UNIVERSITY OF HOHENHEIM

The ‘Uberization’ of agricultural mechanization services:

The case of EM3 Agri Services in Rajasthan, India

Master Thesis

Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics

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Declaration of authorship

I, **Villalba Camacho, Carlos Roberto**, born in Riobamba, Ecuador, with matriculation number 674559; declare that this thesis and the work presented in it are my own. It has been generated as the result of my own original research on the subject "*The 'Uberization' of agricultural mechanization services: The case of EM3 Agri Services in Rajasthan, India"*

I confirm that:

1. This work was done wholly in candidature for MSc degree thesis fulfillment at the University of Hohenheim;
2. Where I have consulted published work of others, that was always clearly credited;
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LIST OF ABBREVIATIONS

CHC	Custom Hire Center
DOA	Department of Agriculture (Jaipur)
EM3	EM3 Agri Services
FGD	Focus Group Discussion
GOR	Government of Rajasthan
IAMAI	Internet and Mobile Association of India
ICT	Information and Communications Technology
INR	Indian Rupees
P2P	Peer to peer
NPM	Net Process Mapping
SE	Sharing Economy
SMAM	Sub-Mission on Agricultural Mechanization
TC	Transaction Costs

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ABSTRACT

Smallholder farmers' access to mechanization in many developing countries remains limited despite its key role for agricultural development. In India, the provision of tractor services has remained largely unorganized and is mainly dominated by large farmers and government custom hiring centers, which have limited scale and reach. In the last years, several start-ups and some machinery manufacturers have developed digital platforms that follow the approach of Uber, aiming to improve the access of smallholders to mechanization services. Accordingly, this trend has been coined the "uberization" of mechanization services. This research analyzes the way in which the business model developed by EM3 Agri Services innovates the provision of machinery services in Rajasthan and aims to improve the farmers' access to it. The study is based on a survey of 101 households, 26 in-depth interviews with EM3 operators and government authorities, as well as focus group discussions and Net Process Mapping with EM3 representatives and EM3 users in five different districts of Rajasthan.

The analysis of EM3's business model shows that the operation is based on the provision of pay-per-use farming services through the establishment of partly-subsidized franchises. However, a digital platform that matches the farmers and the franchises is still not available. The study assesses the way in which different groups of farmers access mechanization services in the study area and evaluates the performance of EM3 franchises compared to the other providers. The results indicate that there are no significant differences in the prices charged by EM3 and the other providers. Nevertheless, the analysis shows that farmers who hire EM3 are able to reduce transaction costs arising from uncertainty and group activities. The study also looks into the challenges faced by the model, including its sustainability without the government subsidy and the limited adoption of ICT technologies by the smallholder farmers, from whom only 26 percent use a smartphone in the study area. The findings offer valuable insights into the underlying dynamics of "uberization" of mechanization and their potential to improve the livelihoods of farmers in developing countries.

Keywords: agricultural mechanization, ICT applications, transaction costs, sharing economy, India.

1. INTRODUCTION

1.1 Problem Statement and Justification of the Study

Smallholder farmers' access to mechanization remains limited in many developing countries despite its key role for agricultural development. In India, the agricultural sector has experienced sustained growth after independence in 1947. This development is commonly attributed to the Green Revolution, which enhanced the utilization of fertilizers, irrigation, improved seeds and mechanization across the country (G. Singh, 2015). Nonetheless, agriculture in India still faces a considerable number of challenges. India is believed to be home to a quarter of the world's hungry people (FAO, 2018), while agricultural production remains resource intensive, raising concerns regarding its sustainability (FAO, 2016). Moreover, there is a continuous reduction in the size of agricultural landholdings, which in 2011 had an average area of 1.16 ha. It is estimated that 85 percent of the farmers operate landholdings smaller than 2 ha (Ministry of Agriculture, 2012).

At the same time, the Indian market for agricultural machinery is one of the most dynamic in the world. The farm power in Indian agriculture has increased at a 4.6 percent rate in the last 40 years (Mehta, Chandel, & Senthilkumar, 2014), and the success of manufacturers such as Mahindra & Mahindra (M&M) and Tractors and Farm Equipment (TAFE) have consolidated the country as the world's leading manufacturer of agricultural machinery (G. Singh, 2015). However, it is estimated that currently, only 45 percent of the national agricultural activity is mechanized (Indian Council of Food and Agriculture, 2017). As suggested by Mehta & Pajnoo (2013), the agricultural sector faces a number of difficulties that affect the farmers' access to mechanization services. The low average size of the farm holdings represents a challenge for the economies of scale of mechanization, especially for operations such as land preparation and harvesting. Moreover, despite the increase in farm power experienced in the last decades, there is still a gap of equipment in order to guarantee the availability of machinery services in many regions. Access to finance is limited and difficult to obtain for smallholder farmers and there is a considerable demand for new contractual arrangements to allow farmers to access agricultural equipment (Mehta & Pajnoo, 2013). Thus, there is a substantial need to find market solutions that allow smallholders to access mechanization services especially as they cannot afford their own machinery.

Mechanization service markets are a potential solution to this challenge. However, in many cases, machinery owners are unwilling to provide mechanization to smallholder farmers as working with them usually encompasses high transaction costs (Daum & Birner, 2017). To reduce these costs and thereby improve the access of smallholders to mechanization services, several start-ups and some machinery manufacturers have been developing digital platforms

that follow the approach of the Uber private-car hire service. Accordingly, this trend has been coined the “uberization” of tractor services (Seth & Ganguly, 2017). Ghana, Nigeria, Kenya, and India are countries where this innovative model has been introduced so far (Forbes, 2018; Hello Tractor, 2019; The Economic Times, 2016a). In the case of India, it has been implemented in several regions since 2014 by several pioneering companies. *EM3 Agri Services*, the first among them, currently holds operations in Rajasthan, Madhya Pradesh, and Uttar Pradesh and claims to have worked with 8,000 farmers with a total of 35,000 working hours on fields (EM3 Agri Services, 2017).

The company works in Rajasthan under a franchise model, in which they encourage local farmers and entrepreneurs to establish Custom Hiring Centers (CHC). Based on an agreement between EM3 and the Government of Rajasthan (GOR), CHCs receive a partial subsidy to obtain new machinery. Each one of the franchisees is supposed to have at least one implement available to offer mechanization for the five stages of the crop cycle (land preparation, sowing, crop care, harvesting, and postharvest). The objective of the business model is to allow smallholder farmers to access the machinery they require without having to buy it. For this, they can reach one of the CHCs through a call center, a digital platform, or by stepping in one of the company’s franchisees.

In this context, this research aims to evaluate to what extent the new models for farm mechanization services follow the Uber idea and whether they reduce the transaction costs compared to conventional models. For this, the model developed by EM3 Agri Services was selected as a case study in order to offer a better understanding of the underlying dynamics by which the uberization can improve the smallholder farmers’ access to mechanization. The state of Rajasthan was selected among the regions where EM3 currently operates since it holds the company’s highest number of operative Custom Hiring Centers and it is the pioneer state where a franchise model was implemented. The study is based on the analysis of quantitative and qualitative information collected during fieldwork between July and September 2018 in the districts of Sri Ganganagar, Bikaner, Jaipur, Bundi, and Kota. A survey of 101 households, 26 in-depth interviews, as well as several focus group discussions and Net Process Mapping with tractor owners and key stakeholders allowed to assess the current state of mechanization services in the area, as well as the potential of EM3’s model.

The content of the research is organized as follows. Chapter 2 introduces the literature review and theoretical background, in which the development and current status of agricultural mechanization in India are discussed. Moreover, considering “uberization” as part of the Sharing Economy (SE), this chapter offers a theoretical framework of the main characteristics of SE, as well as an insight of the most important potential benefits of “uberization” in agriculture.

In Chapter 3, a general description of the study area is presented, followed by an explanation of the methodologies applied. Chapter 4 shows an overview of the importance of transaction costs in mechanization services and the way in which they were estimated in the study. Then, a theoretical preamble of the main governance challenges faced by agricultural mechanization is displayed, as well as the conceptual framework of the provision of mechanization services used for this study.

Chapter 5 presents the most relevant findings of the research. EM3's business model is described in detail, assessing especially the role of the stakeholders who participate in setting up the CHCs and their operation. The farmers' access to mechanization services in the study area is evaluated considering the socio-economic factors, agricultural production characteristics, access to ICT, and type of machinery hired. Moreover, a Transaction Cost (TC) analysis is presented through a rating that aligns the four main contractual arrangements (governance structures) with their attributes for the main machinery hired in the sample. In addition, an evaluation of the organizational and governance challenges faced by EM3's business model is presented.

In Chapter 6 the main points of discussion are presented, focusing particularly on the performance and the potential of EM3's model in the context of the Sharing Economy. Finally, Chapter 7 offers concluding remarks about the study.

1.2 Gap in the Literature

Innovations in technology, processes, and institutions have played a key role in the development of the agricultural sector in developing countries (Ganguly, Gulati, & von Braun, 2017). Permanent innovation is crucial in agriculture considering that an additional 60 percent of production will be needed to feed a 9 billion population by 2050 (Alexandratos & Bruinsma, 2012). This need is even more dramatic in India, which will surpass China as the most populated country by 2022, and will require to rapidly increase the production of food, feed, and fiber (Ganguly et al., 2017). In this regard, increasing the scope of mechanization in Indian agriculture could ensure the increase in yields through timelier operations, more precise cropping procedures, and the reduction of farm drudgery (Singh, 2014). Innovative models, such as "uberization" could play a key role in allowing smallholder farmers to increase their productivity, have access to technology and raise their income.

However, the analysis of the "uberization" of models for agricultural machinery services is still limited. A few studies, such as the ones conducted by Empea Institute (2017), Ganguly et al. (2017), and Seth & Ganguly (2017), and some press releases, such as Business Today (2017), New York Times (2016), The Economic Times, (2016b, 2017), and The Washington Post (2016) have briefly introduced the innovative nature of the ideas implemented by EM3 Agri

Services and other startups. Nonetheless, the literature reveals a lack of evidence of the strategies used by these business models. In addition, crucial aspects, such as the improvement of access to mechanization services for smallholder farmers, the impact on the transaction costs of the service provision, and the effect on providers and users of the service have not been rigorously evaluated.

The “uberization” of machinery services is inspired by the business model implemented by Uber, which is a digital platform that matches drivers and their private cars with riders within a city. It currently operates in 450 cities across 70 countries and represents one of the most popular platforms of the Sharing Economy (SE) together with Airbnb, TaskRabbit, and BlaBlaCar (Constantiou, Marton, & Tuunainen, 2017). According to Lee (2016), the SE currently encompasses five main sectors: peer-to-peer lending and crowdfunding, online staffing, peer-to-peer accommodation, car sharing, and music and video streaming. Nevertheless, so far the literature has not considered agriculture as one of these sectors and has not assessed the impact of emerging companies and startups which implement digital platforms in the provision of farm services. Hence, there is a need to understand the dynamics of “uberization” models in developing countries, together with their limitations and potentials.

In this point, it is important to mention that the development and the impact of new technologies in India are controversial. On the one hand, the considerable development of ICT and the blooming of innovative businesses have been determinant in placing it as the second country with the highest number of startups worldwide, with an estimate of 6,476 (Startup Ranking, 2018). Moreover, based on factors, such as human capital development, research and development, entrepreneurial infrastructure, technical workforce, and policy dynamics, India is currently ranked as the fifth startup friendliest country (CEOWORLD Magazine, 2019). However, at the same time, according to the Internet and Mobile Association of India (IAMAI), it is estimated that only 37 percent of the population currently has access to the internet (The Economic Times, 2018). This situation is more drastic in rural areas, where only circa 21 percent of the population uses the internet.

Therefore, this research aims to offer insights into the way in which “uberization” models for machinery services are currently operating in developing countries. Based on the case study of EM3 Agri Services in Rajasthan, the study intends to broaden the understanding of digital platforms and new business models for mechanization services as well as contributing to assessing their challenges and potentials.

1.3 Objectives of the Study

The purpose of this research study is to (1) analyze the mobile-based-technology developed by EM3 Agri Services and its operation in Rajasthan and to (2) assess the potential of this model to increase the smallholders' access to mechanization services, compared to conventional models.

More specifically, this study aims to determine whether ICT-driven models can play a role in reducing transaction costs to access mechanization services in developing countries, based on the case study of EM3 Agri Services.

The specific objectives of the study are:

- To analyze the main characteristics of Sharing Economy (SE) models based on a literature review and discuss its application in Agriculture.
- To describe the operation of the business model developed and implemented by EM3 Agri Services in Rajasthan.
- To analyze how EM3's business model affects the economic feasibility of providing tractor services to smallholder farmers.
- To assess whether EM3's business model has influenced the access and utilization of tractor services both for tractor owners and for smallholder farmers and the transaction costs of accessing tractor services.
- To identify the organizational and governance challenges that have emerged with the implementation of this business model.

1.4 Research Questions

The objectives of this research study will answer the following questions:

- Which are the main features of the SE and to what extent are they applicable in Agriculture?
- How does EM3's business model work in the field and which stakeholders does it involve?
- Does the model developed by EM3 Agri Services influence the economic feasibility of providing tractor services to smallholder farmers, if compared to other means of service provision?
- Does the model allow to reduce the transactions costs of accessing mechanization services, compared with the other contractual arrangements?
- Which governance and organizational challenges does the model face?

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 The agricultural sector in India

India is the second most populated country, with 1.3 billion people inhabitants, and holds the seventh largest land area in the world (FAO, 2016). Agriculture plays a key role in the economic activity of the country and represents the main livelihood for most of the rural population. In 2017, agriculture contributed with 17.4 percent to the country's Gross Value Added at current prices (Department of Agriculture, 2017) and agricultural land represented approximately 60.4 percent of the total land area (World Bank, 2017). In a national scale, 54.6 percent of the population is engaged in agricultural and related activities, while in rural households it remains the principal source of income for approximately 70 percent of the population (Census of India, 2011).

After obtaining Independence in 1947, India has reduced its reliance on food aid and has become a large food exporter. In fact, India's food grain production has increased from 50 million tons in 1950 to approximately 251 million tons in 2015 (FAO, 2016). Currently, India is the world's largest producer of milk, pulses, and jute and is considered among the largest producers of rice, groundnut, sugarcane, vegetables, wheat, fruit, and cotton (FAO, 2018).

Nevertheless, agriculture in India faces several challenges. First, the growth and diversification of the Indian economy have reduced the participation of agriculture in the country's GDP, which has shrunk from 42 percent in 1960 to 15 percent in 2016 (World Bank, 2016). Second, in spite of having achieved food self-sufficiency, India is home to approximately a quarter of the world's hungry people and 190 million undernourished people (FAO, 2018). Additionally, although production has considerably increased, it remains resource intensive, cereal centric, and regionally based, which raises concerns regarding its sustainability. As a result, land degradation, shrinking biodiversity, and pollution of underground water represent real threats for agricultural development (FAO, 2016).

Table 1. Size of agricultural operational holdings in India (2011)

Land Holding	Operational Holdings (thousands)	Percentage
Marginal (< 1 Ha)	92,826	67%
Small (1 to 2 Ha)	24,778	18%
Semi Medium (2 to 4 Ha)	13,896	10%
Medium (4 to 10 Ha)	5,875	4%
Large (> 10 Ha)	973	1%
TOTAL	**138,348**	

Source: Department of Agriculture Rajasthan (2011)

Furthermore, one of the main challenges that agriculture faces is the reduction in the size of agricultural holdings. Indeed, the total number of operational holdings in the country is constantly increasing, while the land used for agriculture remains limited. Between 2000 and 2011, the number of agricultural holdings has increased by 15 percent, reaching 138 million, while the size of agricultural land has stuck in 159 million hectares. As a consequence, the average area per holding has been reduced from 1.33 hectares in 2000 to 1.16 hectares in 2011 (Ministry of Agriculture, 2012). Moreover, approximately 85 percent of the operational holdings have an area of 2 hectares or less and are considered as marginal and small holdings (Table 1). Therefore, the decrease in the size of farm holdings is one of the most important reasons why many marginal farms are deciding to look for other sources of income than agriculture.

2.2 The development of Agricultural Mechanization in India

The development of the agricultural sector after 1947 allowed the country to reduce its dependence on food aid and boosted the production and exports of food products. In this sense, Singh (2015) considers that while the utilization of fertilizers, improved seeds, and irrigation played the most important role for the development of the Green Revolution in India, agricultural mechanization can be considered as the fourth most important input for this development.

In this sense, Singh's (2015) chronological description of the development of agricultural machinery is summarized in the following section in order the understand how India evolved from being a low-mechanized country to becoming the world’s leading manufacturer.

2.2.1 The initial period (1942 to 1970)

The first tractor arrived in India in 1914, but it was during the mid-1940s that some tractors and bulldozers started being imported. This period can be divided into two sub-periods: the first one took place between 1942 and 1960 when tractors were still not produced in India and imports started growing from 8,000 units in 1950 to 20,000 units in 1955. The second sub-period took place when the manufacture of tractors started in 1961 with an output of 880 tractors by *Eicher Tractors Ltda.* During this period of time, tractors were mainly bought by the government and large private firms, which mostly owned land holdings larger than 10 hectares.

2.2.2 Period of Progress in Agricultural Mechanization (1971 to 2010)

This period was mainly characterized by a considerable increase in the use and demand of agricultural machinery, the consolidation of India as the world’s leader in the manufacturing of tractors, and the emergence of different contractual arrangements which allowed different types of farmers to have access to mechanization.

Between 1971 and 1980, four factors played a key role in the adoption of mechanization. First, six new tractor manufacturing units emerged, which increased the local supply of different kinds of machinery. Moreover, for the first time banks opened branches in rural areas, which made credit available to farmers and allowed them to access means to finance machinery. Additionally, in an effort to foster agricultural production of the country's staple crops, the government established price support mechanisms for grains and sugarcane. Last, custom hiring emerged as an alternative which allowed farmers who were not able to afford own machinery to have access to mechanization. It is estimated that during this decade approximately 60 percent of the annual use of mechanization took place under this kind of contractual agreement.

During the period between 1981 and 1990, the government started emphasizing and promoting the use of tractors among farmers, especially by aiming for affordable machinery prices. In this decade, four new manufacturers emerged. Therefore, after being a net tractor importer up to the 1970s, India became a net producer and exporter during the 1980s. In addition, the government also extended rural electrification, which fostered the farmers' use of pumps and threshers. The decade between 1991 and 2000 was characterized by the wide use of agricultural mechanization among farmers. Custom hiring became a popular way to access machinery for farmers and medium and small entrepreneurs, who not necessarily were farmers, acquired machinery to offer mechanization services.

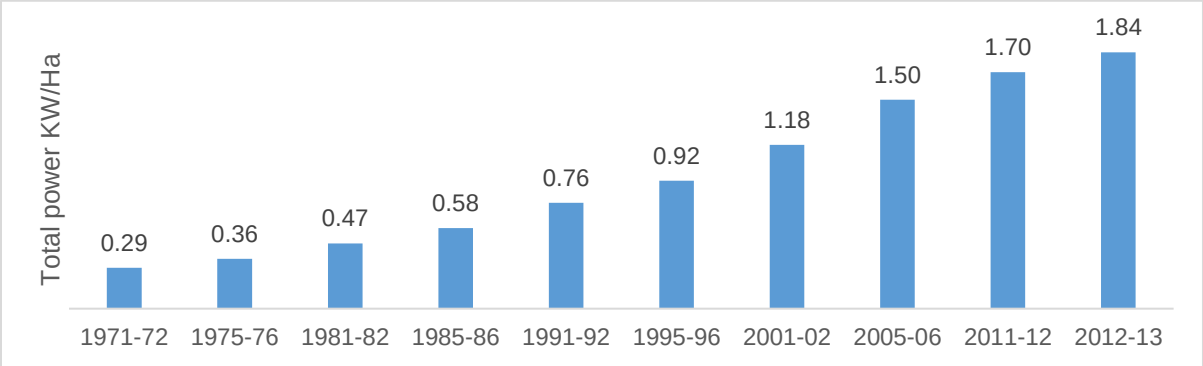
The decade between 2000 and 2010 was a period with a major boom in agricultural machinery manufacturing. In these years, John Deere, Same, and New Holland built their own manufacturing units in India and the Indian manufacturers Mahindra & Mahindra (M&M) and Tractors and Farm Equipment (TAFE) started operations overseas. In addition, according to Singh (2015), the implementation of the Mahatma Gandhi National Rural Employment Guarantee Service has had a tremendous socio-economic impact on agricultural labor. In fact, as a result of its execution wages across India have been increased, which has significantly decreased the number of farm laborers. This situation has offered a considerable boost to mechanization.

2.3 Current status of Agricultural Mechanization in India

2.3.1 Farm Power Availability

Farm power in India is provided by 6 main sources: electric motors, diesel engines, power tillers, tractors, draught animals, and agricultural workers. According to Mehta, Chandel, & Senthilkumar (2014), the availability of the total farm power has increased in a compound annual growth rate of 4.6 percent between 1971 and 2013, augmenting from 0.29 KW/Ha to 1.84 KW/Ha.

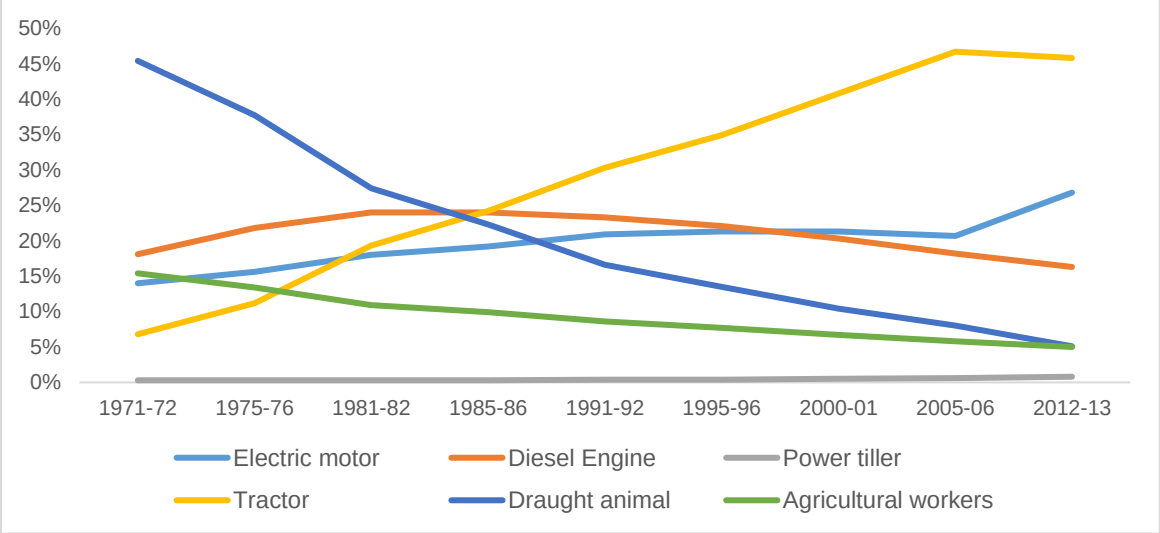
Figure 1. Farm power in Indian Agriculture (1971-2013)



Source: Mehta, Chandel, & Senthilkumar (2014)

In this context, the share of the different power sources has faced many changes in the last 40 years. On the one hand, the use of draught animals has decreased its participation from 45.4 percent in the early seventies to 5.1 percent in 2013 and agricultural workers have reduced their share from 15.4 percent in 1971 to 5 percent in 2013. On the other hand, in the same period, the use of tractor as a farm power source has increased from 6.8 percent to 45.8 percent and the use of electric motors has increased from 14 percent to 26.8 percent. Nonetheless, the use of diesel engines and power tillers has not faced significant changes in the last 40 years (Figure 2).

Figure 2. The trend in the use of power sources in Indian Agriculture (1971-2013)



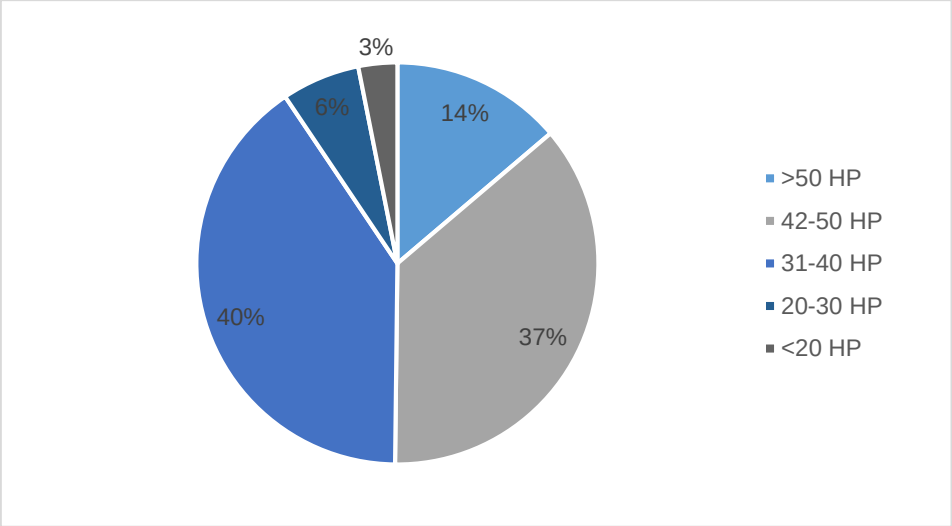
Source: Mehta, Chandel, & Senthilkumar (2014)

As a result of the strong and sustained growth of the use of agricultural machinery during the last decades, it is estimated that the farm mechanization in India stood between 40 percent to 45 percent in 2017 (Indian Council of Food and Agriculture, 2017).

2.3.2 Agricultural machinery market in India

The market for agricultural equipment in India has experienced a prominent and sustained increase in the last decades. In fact, the number of tractors per Sq. Km of arable land has increased from 6.2 in 1970 to 130 in 2000 (The World Bank, 2019). According to Mehta et al. (2014), the sale of tractors has increased at a compound annual growth rate of 10.6 percent between 2001 and 2013, passing from 217,456 units sold to 661,431.

Figure 3. Power-wise sale of tractors in India (2013)



Source: Mehta, Chandel, & Senthilkumar (2014)

In 2013, tractors between 31 HP to 40 HP were the most demanded in the market, with an approximate of 40 percent in 2013. In the second place, tractors between 42 to 50 HP had a share of 37 percent. Tractors with more than 50 HP and less than 30 HP showed a limited demand and, as a group, had a share of 23 percent of the total sales (Figure 3).

Additionally, Table 2 displays the estimations by Mehta et al. (2014), which show the growing demand for new machinery in the Indian market every year. The tractor is still the most required equipment with an estimate of 600,000 new units per year. Among the most demanded machinery, the thresher and the rotavator also have high demand, with an approximate of 100,000 units for the first and a range of 60,000 to 80,000 units for the second.

Table 2. Market overview of agricultural machinery demand in India (2013)

	MACHINERY	ANNUAL MARKET (UNITS)
1	Tractor	600,000
2	Thresher	100,000
3	Rotavator	60,000 - 80,000
4	Power Tiller	56,000
5	Zero till seed drill	25,000 - 30,000
6	Power Weeder	25,000
7	Combine Harvester	4,000 - 5,000
8	Self-propelled vertical conveyer reaper	4,000 - 5,000
9	Laser land leveler	3,000 - 4,000
10	Rice trans planter	1,500 - 1,600
11	Multi-crop planter	1,000 - 2,000

Source: Mehta, Chandel, & Senthilkumar (2014)

2.3.3 Challenges of agricultural mechanization

The Indian market for agricultural equipment is one of the most prominent and dynamic worldwide, especially due to the size of the agricultural sector and the number of farmers with different needs for mechanization. Nonetheless, there is a number of important challenges that currently affect the farmer's access to mechanization services. Mehta & Pajnoo (2013) suggest that the most important challenges for farm mechanization in India are:

i. *The average size of farm holdings:* with an average farm size of 1.16 Ha, farmers in India face a strong imitation to own machinery. In fact, the size of the farms is not convenient for economies of scale, especially for operations such as land preparation and harvesting in small and non-contiguous pieces of land. With the continuous reduction of farm size, the individual ownership of agricultural machinery is not feasible.
ii. *Finance of mechanization:* access to finance is a crucial factor to ensure access to agricultural equipment. In India, approximately 90 percent of the tractors are sold with support from financial institutions, therefore, it is essential to maintain or increase the financial support to allow farmers' access to agricultural equipment.
iii. *Contractual arrangements:* farmers usually face a shortage of capital, which in many cases does not allow them to buy their own machinery. Nonetheless, developing new contractual arrangements and increasing others that already exist, such as custom hiring service, allows farmers to access agricultural equipment. Specifically, there is a need to develop new custom hiring services for high-cost farm machinery, such as combine harvester, laser land leveler, rotavator, paddy transplanter, etc.
iv. *Training:* there is a lack of training and knowledge related to the benefits of mechanization and to the way in which equipment should be used. Moreover, farmers

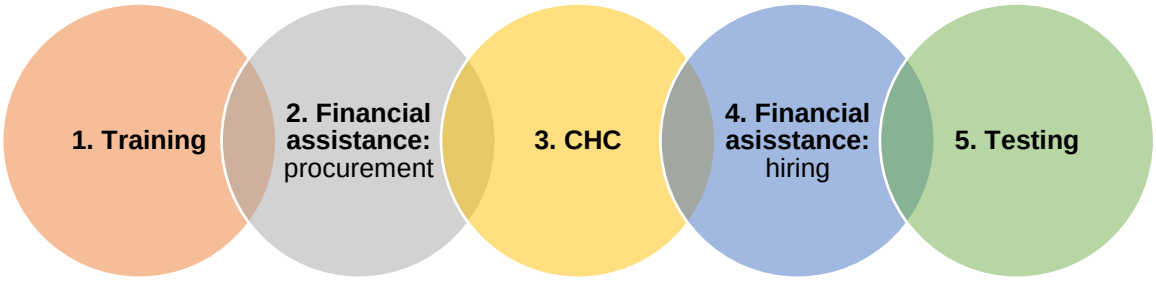
usually lack appropriate guidance for selecting and using machinery, which causes fuel wastage and increases the cost of production.

2.3 The Submission on Agricultural Mechanization (SMAM)

Considering the benefits of increasing the access of smallholder farmers to agricultural mechanization, the deficit of farm power availability, and the low land holding size, the Ministry of Agriculture of India launched the SMAM in 2014. This national program is being adopted in all the states and essentially aims at increasing the ratio of farm power up to 2Kw (Ministry of Agriculture, 2016). The most important objectives that this program aims to reach are:

i. Increasing the reach of agricultural mechanization to small and marginal farmers and to regions of low availability of farm power.
ii. Promoting the development of 'Custom Hiring Centers' (CHC) as an alternative to even up the current economies of scale of small landholding and the high cost of individual ownership.
iii. Spreading consciousness and knowledge about agricultural mechanization through demonstration and capacity building.
iv. Developing hubs for hi-tech and high-value farm equipment.
v. Securing performance testing and certification of agricultural equipment at designated testing centers.

Figure 4. The five strategies of SMAM for increasing the reach of agricultural mechanization



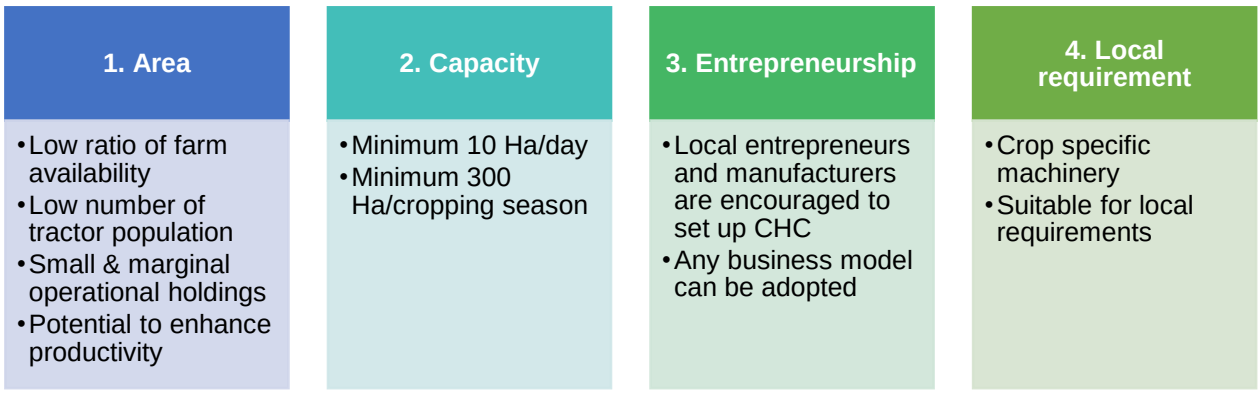
Source: Ministry of Agriculture (2016)

To achieve these objectives, SMAM is adopting five core strategies. First, it aims to promote training and demonstrations of farm equipment among different stakeholders. In addition, it intends to provide farmers with financial assistance which allows them to acquire farm machinery and implements. Third, it strongly fosters the establishment of CHC in regions where farmers are not able to afford their own equipment. Moreover, the fourth strategy offers financial assistance to small and marginal farmers who need to hire machinery and implements from CHC in low mechanized regions. Lastly, the testing of farm machinery and equipment is

developed by the Machinery Training and Testing Institutes and designated State Agricultural Universities (Figure 4).

In what refers to the establishment of CHC, the main goals that this initiative aims are: i) to enhance mechanization in districts with low farm power availability, ii) to provide CHC with equipment for different operations, iii) to promote mechanized activities for small and marginal farmers, iv) to include the equipment manufacturers in the training for operation and maintenance in CHC, and v) to bring in advanced and newly developed agricultural equipment in the crop production (Ministry of Agriculture, 2016).

Figure 5. Area, operation and composition of CHC



Source: Ministry of Agriculture (2016)

Four criteria are taken into consideration to select the area and to monitor the operation of a CHC, as displayed in Figure 5. First, the selected area should have a shortage of agricultural machinery, a large number of small and marginal farmers, and the potential to enhance productivity. Second, the CHC must have a daily work of at least 10 hectares and 300 hectares per cropping season. Third, entrepreneurs can apply to district level agencies to set up a new CHC. Local people and manufacturers are particularly encouraged to establish the CHC. The beneficiaries are free to choose the brand and the type of equipment, as long as it has been previously tested and approved by the government authorities. Lastly, a CHC should be able to satisfy the local machinery requirements, taking into consideration the crops locally grown and the type of machinery required for their production.

To set up a CHC, financial assistance is available for rural entrepreneurs for up to 4 years; moreover, a subsidy between the range of 25 to 40 percent is offered for individual ownership of farm machinery. Until 2017, an approximate of 1.4 billion rupees (17.5 million Euro) have been released as a cost subsidy for machinery the procurement of 1,834 CHC (Department of Agriculture, 2017).

2.4 The Sharing Economy and the 'Uberization' of agriculture

In the last years, the technological advances in GPS, social networking, cloud computing, and mobile communications have revolutionized services provision around the world. In fact, transport, food, beverage, accommodation, retail, and logistics industries have entered in a new way of doing business (Lee, 2016). The way in which supply and demand traditionally operated has changed, and there is a disruption in the conception of the users and providers of services (Botsman, 2013). These series of changes in the economy are currently referred by the literature as the *Sharing Economy (SE).* Common examples of these new models can be found in the way companies such as Airbnb, Uber, and Zip Car currently operate.

In the case of India, this global trend, together with the need to increase the farmers' access to agricultural mechanization has set the ground for the emergence of innovative business models which intend to upgrade the traditional custom hiring market to a new level. Thus, "uberization" has risen as an alternative that aims to promote a more effective and affordable provision of machinery services, based on the use of mobile tools. In this section, first, a brief overview of the definition, characteristics, and development of the SE is presented. Moreover, an introduction to the main attributes of the SE and "uberization" in the field of agriculture is displayed.

2.4.1 The Sharing Economy

There is not yet a consensus in the definition of the Sharing Economy. Different contexts, industries, and authors display an understanding with diverse features about this topic. Yet, one of the most commonly accepted definitions is the one formulated by Stephany (2015, p.9), who referrers to the SE as "the value in taking underutilized assets and making them accessible online to a community, leading to a reduced need for ownership of those assets". According to Lee (2016), the size of the SE is expected to increase from US$ 15 billion in 2014 to US$ 335 billion in 2025, including its main five sectors: (i) peer-to-peer lending and crowdfunding, (ii) online staffing, (iii) peer-to-peer accommodation, (iv) car sharing, and (v) music and video streaming.

Although an agreed definition is not offered by the literature, there is a group of authors who have developed frameworks in order to assess the implications of SE. Table 3 shows a summary of the nine most important characteristics of SE, according to the literature review.

Table 3. The main characteristics of the Sharing Economy according to the literature review

	Characteristics	Author (s)				
		Sundararajan (2016)	**Botsman (2015)**	**Gansky (2011) & (2014)**	**Miralles et. Al (2017)**	**Stephany (2015)**
1	High Impact capital "Idling capacity"	X	X	X	X	X
2	Peer to peer activity (P2P)	X	X	X	X	X
3	Crowd-based networks	X	X	X	X	
4	Shareability			X		X
5	Digital-technology-based			X		X
6	Market based, value oriented	X				X
7	Trust/ reputation systems	X	X	X	X	
8	Value-driven		X			
9	Changes in Labor	X				

The red color is given to characteristics for which there is a common agreement among different authors. The yellow color is given to characteristics which are partially agreed among the literature. The green color is given to characteristics that show different opinions or that are not taken into consideration by all the authors.
Source: The Author

The three factors which show an agreement among the literature, and seem to be the most influential to identify Sharing Economic activities, are:

1 **High-impact capital:** according to Sundararajan (2016), what makes SE business models different and innovative, is their capacity to use assets such as time, skills, and money at their full capacity. This means turning the asset's downtime or *"idling capacity"* into revenue and, therefore, obtaining additional value from them (Stephany, 2015). The new social, location-based, and mobile technologies allow matching people who have this idling capacity with those who need it (Botsman, 2013).

2 **Peer to peer (P2P) activity:** the new technological platforms and networks enable the direct person-to-person exchange of products and services, based on peer trust (Botsman, 2013). In fact, the technology works as a determinant factor to achieve transparency and accountability among peers, which enables the users and providers to manage trust in markets and platforms (Gansky, 2014).

3 **Crowd-based networks:** Sundararajan (2016) argues that in SE models, the supply of labor and capital comes from decentralized crowds of individuals, which replaces the role of centralized institutions or third parties as mediators in the marketplaces.

In addition, there is a group of characteristics of the SE models for which the authors agree partially and seem to reflect complementary features.

4 **Shareability:** Products or services are shared within a community and, therefore, there is a reduced need for ownership (Gansky, 2010). Additionally, the SE models move beyond the dichotomy between production and consumption and allow a co-production and co-consumption (Miralles, Dentoni, & Pascucci, 2017).

5 **Digital technology based:** according to Belk (2014), the fast development of SE models is partially explained by Web 2.0 and its ability to enable users to connect and contribute with each other. Stephany (2015), also mentions online accessibility as a key feature that allows a direct and immediate exchange of goods and services when listed online.

6 **Market-based and value-oriented platforms:** SE usually creates reciprocal economic value, which is reflected in markets that enable the exchange of goods and services, with a higher level of economic activity (Sundararajan, 2016; Stephany, 2015).

7 **Trust/reputation system:** Botsman (2013) and (Miralles et al., 2017) argue that SE platforms heavily rely on the trust between members who commonly do not know each other in person, but develop trust-based relationships among a sharing community. Therefore, trust and reputation are constantly built through the economic exchange in a "digital community" (Sundararajan, 2016).

Finally, there are two characteristics of SE models which seem to show less agreement for the different authors.

8 **Value-driven:** Botsman (2015) argues that SE represents a "value shift", in which companies and transactions do not only intend to generate profit but are rather built on meaningful principles such as, collaboration, empowerment, transparency, humanness, and authenticity.

9 **Changes in labor:** Sundararajan (2016) suggests that SE platforms show blurring lines between the personal and the professional, which scales up activities that used to be considered as personal to professional activities through peer to peer activity. Additionally, blurring lines between fully employed and casual labor reflect a new scenario in labor, in which traditional full-time jobs are replaced by contract work.

From a different perspective, Towson (2017b) argues that in the case of China, for example, many businesses do not follow the approach suggested by SE models. Instead, he suggests that an emergence of new digital disruptors is taking place, in which the new digital tools can disrupt the demand, the supply, or both. According to his approach, the term "sharing" can be fuzzy and misleading since usually, this term involves the use of a physical product or asset. Nonetheless, what is actually taking place in the economy also reaches transactions of labor, data, services, and intangible assets. Furthermore, he argues that although SE models aim at

sharing assets, there are grey areas between the rental business and the SE. Additionally, when the SE platforms or companies own a number of assets and make them available online for people to share its use, it is questionable whether this should be understood as merely sharing or rental.

As part of his approach, Towson (2017b) suggests that there are five main disruptors of the Sharing Economy in the case of several businesses (Table 4) and that they should be analyzed in order to determine whether a business model should be understood as part of the Sharing Economy or not.

Table 4. The Sharing Economy disruptors

Disruptor	Main features
1. Ownership or Access?	Whether the model offers an alternative to ownership *(and whether it competes with ownership business)*
2. Demand disruptor	1) Does the model lower price? 2) Does the model increase convenience*? ("make it easy and make it now")*
3. Supply disruptor	1) Access latent supply? *(Access to supply that was previously impossible or uneconomic to provide)* 2) Makes supply available in smaller increments? *(adding their own assets and making them available)*
4. Leverages Non-Owned Assets?	Does the company have to own the assets, or can it leverage them from others?
5. Is there a network effect or other competitive advantage?	1) Network effect? 2) Economies of scale? 3) A subsidy, standardization play or data advantage?

Source: Towson (2017a)

2.4.2 Uberization in agriculture

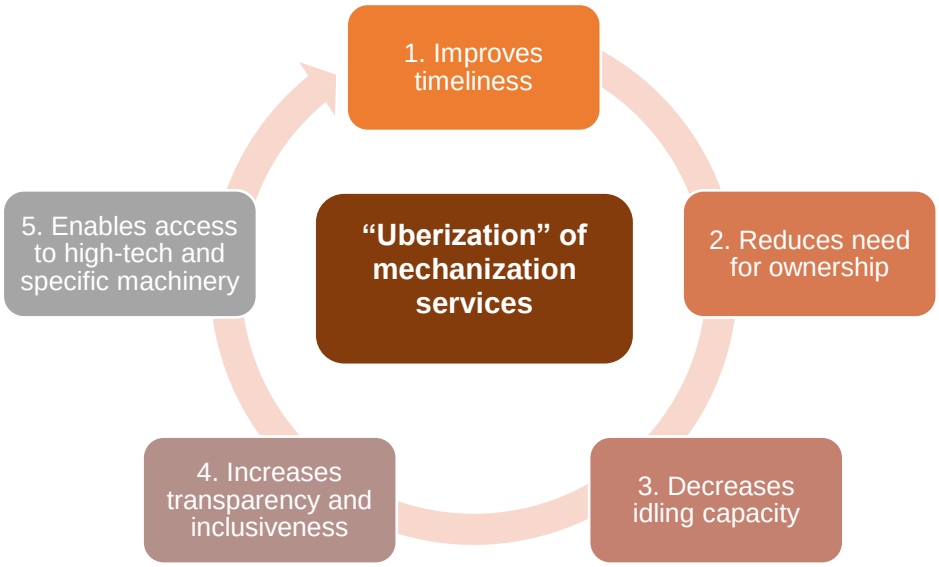
The term “uberization” was popularized by Maurice Lévy during a series of interviews between 2014 and 2015, where he defined it as the capacity of improving an existing business model by adopting new mobile technologies (David, Chalon, & Yin, 2016; Financial Times, 2014; The Economic Times, 2015). The verb to *“uberize”* is already defined by the Cambridge Dictionary (2019, para. 1) as the ability “to change the market for service by introducing a different way of buying or using it, especially using mobile technology”.

During the last years, several initiatives which aim to develop an Uber-based approach in agriculture have emerged around the globe. The “*uberization” of tractors and farm machinery*, as some have coined it (Seth & Ganguly, 2017), refers to the development of mobile/smartphone tools that follow the approach of the Uber private-car hire service, and aim to connect demand and supply of farm equipment. Considering that in the farm context, the equipment is the second-largest expense after the land and that this equipment usually has a large idling capacity, the main idea of these business models is: i) to allow access to

mechanization services to farmers who are not able to buy agricultural machinery, and to ii) help machinery owners make money by renting their equipment to those farmers who cannot afford the cost of buying the machines. In the case of the United States, for instance, it is estimated that there is an equivalent of US$ 244 billion worth of machinery and equipment across the country's farms (The Washington Post, 2016), which remain idle during a long time over the year.

By implementing internet technology, financial services, cloud technologies, and mobile telecom services, the Uber models in agriculture aim to "significantly increase the reach of farm mechanization and enable digital empowerment of the farmers" (The Economic Times, 2017, para. 4). In the last years, several newspapers, business portals, and agricultural blogs have briefly documented the development of the "uberization" of mechanization services (Forbes, 2018; New York Times, 2016; The Economic Times, 2017; The Telegraph, 2016; The Washington Post, 2016). Although the full potential and possible effects of these business models have still not been analyzed, the limited literature claims that they could be a solution to some of the most crucial challenges of farmers regarding mechanization. Figure 6 summarizes the main potential benefits attributed to the development of "uberization" models in agriculture, followed by a brief description of each one of them.

Figure 6. Claims of most important benefits of "uberization" in agriculture



Source: The Author

1. *Improvement of timeliness:* although farmers have shared and rented out machinery locally for a long time, one of the most important challenges they still face is the timeliness of the growing seasons. Indeed, there are windows of time during the agricultural production cycle when most of the farmers in the same area need the same equipment at the same time. Using the Uber models could help farmers to look

for machinery outside their neighborhood since in different regions the growing cycles and the agricultural equipment required are different (The Washington Post, 2016).

2. *Reduced need for ownership:* different business approaches based on mobile services, such as online renting or pay-per-use, enable farmers to access to mechanization services without any investments in the asset (The Economic Times, 2017). In fact, even in cases when equipment needs to be transported for a long distance, and the transporting costs increase the price of the service, still many farmers save money by renting rather than buying (The Washington Post, 2016).
3. *Decrease of idling capacity:* peer-to-peer models allow rental of high-value assets that are not being utilized at their full capacity (The Washington Post, 2016), such as tractors, planters, and combine harvesters. This allows connecting equipment owners who have an idle time of their machinery with farmers from other areas who need it.
4. *Increase of transparency and inclusiveness:* due to its peer-to-peer nature, these platforms also have the potential to reduce the discrimination on the basis of caste, gender, or land size (Daily Hunt, 2015). Additionally, online bidding usually makes these models more transparent and accountable for the user and the provider of the service (Farmer's Weekly, 2018).
5. *Access to high-tech and specific machinery:* Ganguly, Gulati, & von Braun (2017) argue that the Uber-approach could increase the smallholder farmers access to various types of farm equipment which are appropriate for specific types of crops and soils. Moreover, for farmers with limited economic resources, these platforms could represent the only alternative they have in order to use advanced-technology machinery.

3. STUDY SITE, METHODOLOGY, AND DATA

3.1 Description of the study area

The analyses presented in this thesis are based on quantitative and qualitative information collected by the author between July and September 2018 in five different districts of Rajasthan, in cooperation with EM3 Agri Services. The state of Rajasthan was selected among the states where EM3 currently operates because it holds the highest quantity of operative Custom Hire Centers, and it is the pioneer state where the franchise business model started operating. In this section, a brief overview of the agricultural sector in Rajasthan is presented followed by a description of the districts where the data was collected.

3.1.1 Agriculture and climate conditions in Rajasthan

Rajasthan is the largest state of India, with 10.4 percent of the total geographical area, and holds 5.7 percent of the total population (Government of India, 2011). The state has 33 districts, which are further subdivided into 244 tehsils, and 9,168-gram panchayats. Geographically, Rajasthan is divided into 4 main regions: (i) the western desert with rocky and sandy plains; (ii) the Aravalli hills running south-west to north-west; (iii) the eastern plains with rich soils; and (iv) the south-eastern plateau (Swain, Kalamkar, & Ojha, 2012). The arid zone in Rajasthan represents approximately 61 percent of the state, therefore, most of the state's territory faces constant challenges regarding access to water. Droughts are perceived as a recurrent phenomenon since the state only holds approximately 1 percent of the water resources in the country (Swain et al., 2012). There is a high reliance on rainfall and only 34.5 percent of the net sown area is irrigated (Government of Rajasthan, 2016). The average rainfall in the state is 57.4 cm per year, compared to a country average of 110 cm. Furthermore, there is a wide range of temperature variation, which contrasts from 3°C during the winter and 48°C during the summer (Government of Rajasthan, 2016).

In spite of the challenging climatic conditions, agriculture is the backbone of the economy in the state. It represents 23 percent of the Net Domestic Product and it is estimated that 65 percent of the population relies on this activity as the main source of income (Swain et al., 2012). Rajasthan is India's largest producer of mustard, coriander, pearl millet, beans and the second largest producer of milk (Swain et al., 2012). The state has two agricultural seasons: Rabi and Kharif. During the Rabi season, the cycle starts around mid-November, and harvesting takes place between April and May. The main crops produced in Rabi are wheat, mustard, and gram. In Kharif, crops are cultivated during the rainy season, which lasts from

April to October (National Food Security Mission, 2016). In this season the most produced crops are bajra[1], guwar seed[2], and moong[3] (Government of Rajasthan, 2016).

Table 5. Landholding in Rajasthan, compared to the national average

Type of holding	India	Rajasthan
Marginal (< 1 Ha)	67.1%	36.5%
Small (1 to 2 Ha)	17.9%	21.9%
Semi Medium (2 to 4 Ha)	10.0%	19.4%
Medium (4 to 10 Ha)	4.2%	16.4%
Large (> 10 Ha)	0.7%	5.9%

Source: Department of Agriculture Rajasthan (2011)

When compared to the national average of landholding size, Rajasthan shows a relatively different pattern. As displayed in Table 5, in this state the landholdings are, on average, larger than in the rest of India. The marginal and small landholdings, composed by farmers who operate a field up to 2 hectares, account for 58 percent of the total holdings, while in the national average they represent 85 percent of the total holding. In fact, the small, semi-medium, medium, and large landholdings represent a larger share when compared to the national average.

In this context, Rajasthan faces a number of challenges in agriculture, from which according to the Government of Rajasthan (2012) the most prominent are: (i) frequent droughts, (ii) climate change and global warming, (iii) lack of technology to promote dryland/arid agriculture, (iv) deteriorating soil health, and (v) low productivity.

3.1.2 Areas of data collection

Taking into consideration the limited access to water across the state, EM3's initial strategy is focused on implementing CHC in areas with higher rainfall or access to irrigation channels. As a result, the first centers started operating in Kota and Bundi, which are districts with humid climate located in the south-east of the state. In addition, the north-west arid districts of Bikaner and Ganganagar, which have access to the Indira Gandhi irrigation channel, concentrate the largest number of CHC. As displayed in Table 6, until September 2018, EM3 implemented a network of 29 CHC across Rajasthan.

[1] It is a grain commonly used to make the flat bread bhakri. Rajasthan is the highest-producing state in India.

[2] Guar gum, a substance made from guwar which has thickening and stabilizing properties useful in various industries, traditionally the food industry.

[3] Green bean.

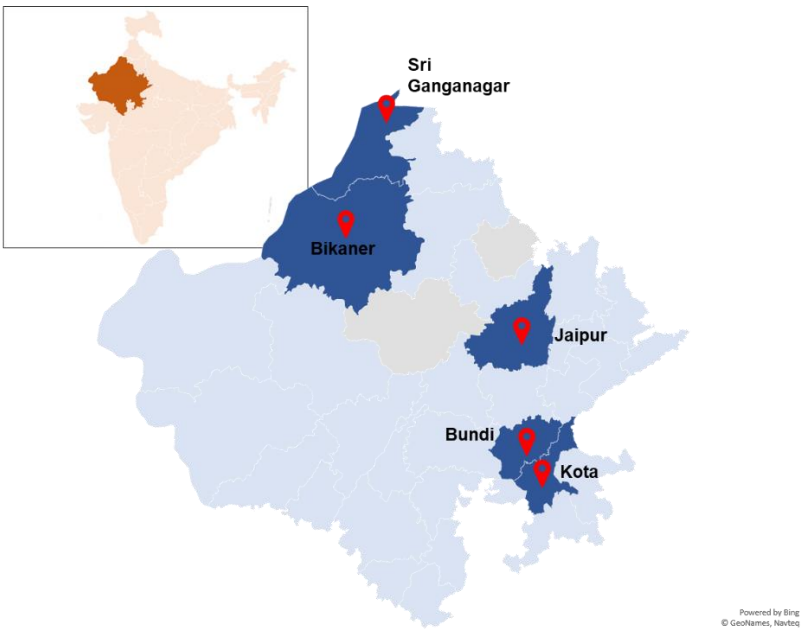
Table 6. Districts in Rajasthan with EM3 CHC franchisees by September 2018

	District	Franchisees established
1	Baran	2
2	Bikaner	8
3	Bundi	5
4	Chittaurgarh	1
5	Dungarpur	1
6	Ganganagar	1
7	Hanumangarh	5
8	Jaipur	1
9	Kota	4
10	Tonk	1
	TOTAL	**29**

Source: EM3 Agri Services

For this study, the districts of Ganganagar, Bikaner, Jaipur, Kota, and Bundi were selected for data collection. In Sri Ganganagar and Bikaner, interviews with CHC owners, and applicants for the franchise model were conducted. In Jaipur, interviews with government authorities and EM3 representatives were performed, as well as net process mapping. In Bundi and Kota, a survey was conducted to farmers who access to mechanization services with EM3 and with other providers. Additionally, interviews and net process mapping with EM3's franchisees were developed.

Figure 7. Localization of study areas in Rajasthan



Source: The Author

3.2 Types and sources of data

Qualitative methods were used in order to capture the essence of the local context, the links between the stakeholders, and their perspectives about the mechanization services. The following methods were conducted for data collection in the districts visited:

1. **Stakeholder analysis:** identification of the key stakeholders involved in the provision of mechanization services, as well as their impact and influence on the process.
2. **Interviews:** semi-structured interviews conducted to the main stakeholders and institutions which participate in the provision of mechanization services.
3. **Net Process Mapping:** developed with some of the stakeholders to display the flows of information, financial resources, complains and identify the bottlenecks of the process and the most influential actors.
4. **Focus Group discussions:** conducted with representatives of different groups of stakeholders in order to discuss the impact of the model at the community level**.**

Quantitative methods were used in a survey to measure the social and economic conditions of the farmers, the access to ICT, the access to mechanization services, and to estimate some transaction costs.

5. **Survey:** conducted in the districts of Bundi and Kota to farmers who have used the mechanization services offered by EM3 Agri Services and other contractual arrangements. The period of reference for the survey was Rabi 2017/2018 and Kharif 2018. The survey covered 5 sections:

    A. Household demographic and economic information
    B. Mechanization ownership
    C. Access to mechanization hiring services
    D. Land use and crop production
    E. Access to mobile and internet services

    A standardized questionnaire was designed using the free software developed by the Word Bank *Survey Solutions*. The survey was conducted using smartphones to collect information from the respondents. Finally, the data collected was analyzed using *Microsoft Excel* and *Stata 15.0*.

3.3 Sample size

1. **Interviews:** 26 interviews were conducted across the 5 districts visited in Rajasthan.

Institution/Stakeholder	Interviews
EM3 Representatives	5
EM3 franchisees (Sri Ganganagar, Bikaner, Kota, Bundi)	15
Rajasthan Government authorities	1
Jaipur Agricultural Department authorities	2
Kota Agricultural Department authorities	2
Financial Institutions representatives	1

2. **Net Process Mapping:** 2 NPM were developed in Kota and Jaipur.

Topic	Participants
The process to establish an EM3 CHC	EM3 Representatives
EM3 mechanization provision service in the field	EM3 Franchisees

3. **Focus Group Discussions:** 2 informal FCD were conducted in Kota.

Topic	Participants
Access to mechanization before and after EM3	7 users of EM3's service
The use of Uber and Ola platforms in comparison to EM3 in India	3 EM3 extensionists

4. **Survey:** 101 farmers in Bundi and Kota

3.4 Sampling techniques

For the qualitative methods, snowball and purposive sampling were used in order to identify the key stakeholders involved in the mechanization services scheme developed by EM3.

For the quantitative methods, a mixture of different sampling methods was used. First, purposive sampling was performed to select the locations where the survey was to be implemented. Considering that EM3's model is relatively new and is operating only in some specific areas in Rajasthan, this technique was performed to include the locations with operative CHCs in the sample. Bundi and Kota were chosen because these are the districts where EM3-CHC model was first applied in Rajasthan. Then, based on the type of contractual arrangements, the respondents were selected using two different methods: snowball sampling (1) for EM3 users, and (2) cluster sampling for users of other contractual arrangements. For cluster sampling, farmers who use mechanization services were randomly selected from the same or neighboring gram panchayat where one of EM3's CHC is established.

4. CONCEPTUAL CONSIDERATIONS AND FRAMEWORK

4.1 Transaction costs in agricultural mechanization

Agricultural transactions offer a rich arena for the application of transaction cost analysis (Masten, 2000). A growing number of studies have implemented this approach to analyze different issues in agriculture, such as access to markets, information asymmetry, risk and uncertainty, property rights, and institutional failures (Cuevas, 2017).

According to Williamson (1985, p.2), the transaction cost analysis (TC) allows to "examine and compare the costs of planning, adapting, and monitoring a task completion under alternative governance structures". As suggested by Wander (2002), in order to empirically apply the TC approach, it is crucial to first identify the main attributes of the transactions. Williamson (1985) considers uncertainty, frequency, and asset specificity to be the main attributes of transactions. In addition, Shelanski & Klein (1995) suggest that complexity should be considered as part of the attributes. Barzel (1982) also considers measurability should be added as an important attribute of the transactions. In this sense, what matters the most in the transaction cost analysis is not the sum of transaction costs, but the relative standing of TC linked with different organizational or contractual arrangements (Wang, 2003). The transaction cost analysis assumes that contractual arrangements which reduce TC boost the participation of farmers in a specific market, and therefore, allows them to increase productivity and alleviate poverty (Cuevas, 2017).

This study follows the TC approach developed by Wander, Birner, & Wittmer (2003), and considers 4 of the TC estimated in this study. The definition and methodology used to estimate the most important TC for the contractual arrangements are as follows:

1. **Asset specificity:** assess to what extent the machinery's operation is limited to certain crops or activities. In the sample, it is measured by evaluating the number of production stages in which the machinery was used.
2. **Uncertainty:** refers to which degree timeliness affects the outcome of the transaction. For this study, the level of uncertainty was estimated by assessing three aspects of the transactions. First, the number of days spent on finding a provider with the right machinery was used to estimate the planning time. Then, the number of days that the farmer had to wait for the provision of the mechanization services, once the request had been done, was used as a proxy for the waiting time. Lastly, the degree of availability of the machinery was estimated by the number of times that the machinery was not available for the farmers in the last year.

3. **Frequency:** refers to the frequentness of transactions between the users and the providers. Its importance is related to the outcome of repeated interactions, which incentives the stakeholders to maintain a reputation for fair dealing. This could be crucial to reduce opportunism, even in the absence of contracts (Klein, 2006). In the sample, it is estimated by evaluating the number of times that the household hired machinery with a specific provider.
4. **Requirement of group activities:** to what extent the tractor owners ask farmers to perform group activities in order to provide the service. For this study, these activities were related to whether the farmers needed to come together in order to add up an area of land that would be attractive to the mechanization provider.

4.2 Governance challenges of agricultural mechanization

The term governance has been used for several years by development agencies in order to refer to the way in which the political, administrative and economic authority can be managed in a country's affairs (UNDP, 1997). However, as suggested by Doornbos (2003), there has not been a consensus about its use and scope and the literature refers to governance in different contexts. In general, the evaluation of governance is related to the indicators of good governance, such as government effectiveness, control of corruption, regulatory quality, voice and accountability, political stability, and rule of law (Kaufmann, Kraay, & Mastruzzi, 2009). Institutional Economics has also used the term by relating it to the institutional structures and processes for managing economic affairs. In particular, the focus developed by the New Institutional Economics (NIE) allows performing an institutional analysis, based on both formal institutions, such as governments or markets, and informal institutions, which are common in developing countries (Kherallah & Kirsten, 2010). In this context, in order to identify the main governance challenges related to the provision of mechanization services by EM3, this study uses the Institutional Economics approach based on the framework developed by Daum & Birner (2017).

According to the authors, the challenges of agricultural mechanization are aligned with the structures or institutional settings under which the mechanizations services are provided. Although the original framework uses three different governance structures (market governance, state governance, and community governance), this study focuses only of the first two categories due to the nature of the business model developed by EM3.

Market failure

Markets can be considered as not successful in distributing resources when its allocation is not efficient for society (Bator, 1958). In this sense, although Daum & Birner (2017) describe

six main sources of market failures for agricultural mechanization, this section only focuses on the four categories identified for the case of EM3.

1) **Indivisibility:** the provision of mechanization services involves the operation of economies of scale, which can be challenging if farms are small and fragmented (Daum & Birner, 2017; Mrema, Baker, & Kahan, 2008). In the study area, although EM3's approach aims to offer a solution for this issue, the impact on small and marginal farmers still seems to be limited.
2) **Merit goods:** the authors suggest that market failure can arise in the provision of public goods which are crucial for the development of mechanization. In the study, the failure in the provision of merit goods is related to the development of skills. Indeed, since tractor dealers are usually not interested in providing training on not-brand specific mechanization, and tractor owners do not appreciate the positive effects of having qualified operators, there is a gap in training due to market failure.
3) **Information asymmetry:** in the study, the lack of trustworthy information about the land sizes is considered to generate market failure. Service providers usually fail to estimate the price they should charge for the service because often farmers either do not know the right amount of land they own, or they declare it to be smaller.
4) **Principal-agent problem:** EM3's mechanization provision is based on a franchise model, in which either the franchisee's owners or operators hired by them are the ones providing the on-farm services. Therefore, principal-agent problems are considered to emerge from two different sources: i) fulfillment of minimum hours of service provision, and ii) quality of on-farm service provision.

State failure

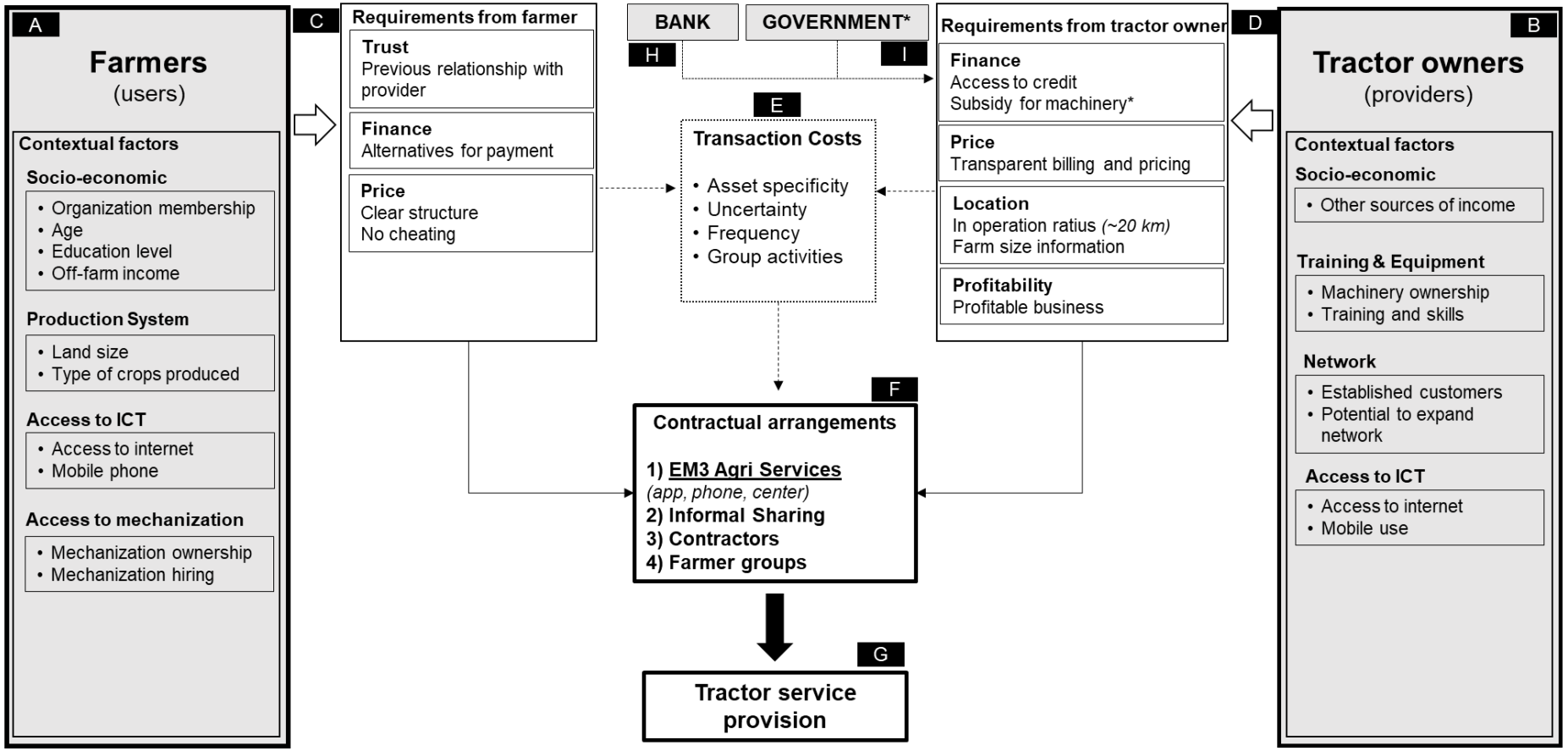
Considering that the development of EM3's model is closely related to the implementation of the Submission on Agricultural Mechanization, which is coordinated by the government, it is essential to assess the sources of state failure. The evaluation of EM3's model suggests that there are two categories of challenges related to state governance.

1) **Lack of financial sustainability:** the business model strongly relies on the 40 percent subsidy for the acquisition of new machinery. Hence, there is a need to evaluate whether the business model can be effective and sustainable without the provision of the subsidy.
2) **Information problems:** as suggested by Daum & Birner (2017), governments often fail to successfully link demand and supply of mechanization services. In this sense, it is crucial to assess whether there is a concentration of mechanization services provision in regions which already have high access to it.

3) **Elite capture:** as a consequence of the provision of the subsidy for new machinery, the selection of franchises could be affected by elite capture. Indeed, this challenge emerges when governments target powerful farmers for the provision of private goods, such as machinery, for political purposes (Daum & Birner, 2017; Mrema et al., 2008).

4.3 Conceptual Framework

Figure 8. Conceptual Framework of Mechanization Services Provision in Rajasthan



*Subsidy for machinery in agreement with the Government is only provided under EM3 Agri Services scheme.
The assessment of the different sections of the Conceptual Framework is as follows: Box A is analyzed in section 5.2, Boxes B and C in section 5.4, Box D in section 5.1, Boxes E and F in section 5.3. Boxes H and I are considered as part of the analysis in section 5.1.

Source: The Author

Figure 8 displays the Conceptual Framework for the understanding and analysis of agricultural mechanization services in Rajasthan. Overall, mechanization services are considered to be the result of the interaction between the farmers (users) and the machinery owners (providers). First, this framework considers the contextual factors (boxes A and B) that influence the farmers' and tractor owners' requirements for mechanization services. In addition, the framework considers the requirements of the farmers and the providers for the provision of mechanization services. In the case of the farmers (box C), the requirements to hire tractor services are related to (i) trust, (ii) finance, and (iii) price. For the tractor owners (box D), the requirements in order to provide mechanization services deal with (i) finance, (ii) price, (iii) location, and (iv) profitability. It is noteworthy, that in the case of the tractor owners, the fulfillment of the requirements has a direct influence on the type of contractual arrangement they decide to undertake. Furthermore, the framework considers transaction costs as a key factor which influences the actors' decisions to hire and offer mechanization services (box E). As a result of the fulfillment of the requirements, and the evaluation of transaction costs, the farmers select the contractual arrangement which is more convenient for them (box F). In the same way, the tractor owners choose the contractual arrangement that allows them to provide mechanization services and fulfill their requirements. As a result, a tractor service provision takes place between farmers and tractor owners (box G).

In the scheme, Banks (box H) play a complementary role to offer financing options to tractor owners. In addition, the Government of Rajasthan (box I) offers a subsidy for agricultural machinery, working specifically in coordination with EM3. Therefore, among the different options of contractual arrangements, tractor owners who wish to apply for a machinery subsidy need to work with EM3.

Contextual factors and requirements from the Users

In the case of the farmers, information about the contextual factors was collected through the survey implemented in Bundi and Kota. For factors are considered to describe the conditions of the households in the study area:

(i) socio-economic factors: age, gender, and education of the household head, whether the household head belongs to an organization, and whether the household has an off-farm income.
(ii) production system: the size of the landholding, and the type of crops produced.
(iii) access to ICT: whether the household has access to the internet and whether the household head owns a mobile phone.
(iv) access to mechanization: whether the household owns agricultural machinery, and whether the household hires mechanization services from someone else.

Information about the most important requirements for the farmers was collected from FGD and interviews with key stakeholders. From the study, the key requirements in the study area refer to:

- Trust: refers to the conviction of the farmer that the tractor owner will perform good quality and timely work. The generation of trust usually comes from a pre-existing relationship with the service provider or from references.
- Financing: farmers in the area usually prefer to be offered alternatives for payment, which could take place some weeks after the service provision or at the end of the harvest.
- Price: a clear and honest structure of the way the price is estimated is highly appreciated by the farmers when selecting a contractual arrangement.

Contextual factors and requirements from the Providers

In the case of the tractor owners, information about the contextual factors was collected through in-depth interviews with the operators and applicants of EM3 franchisees. Five factors are considered to describe the conditions of the tractor owners in the study area:

(i) socio-economic factors: gender of the tractor owner and evaluation of other sources of income.
(ii) training and equipment: the type of machinery owned by the tractor owner, as well as the experience and training to operate it.
(iii) network: the number of regular clients and the potential to increase it.
(iv) access to ICT: whether the tractor owner has access to the internet and owns a mobile phone.
(v) location: district and gram-panchayat.

Information about the most important requirements for the tractor owners was collected from NPM and interviews. From the study, the key requirements in the study area refer to:

- Finance: tractor owners typically need access to credit in order to finance the acquisition of new machinery. Access to subsidy and access to credit by EM3 provide an incentive to tractor owners to select this contractual arrangement.
- Price: tractor owners face constant issues in order to collect money from farmers after service provision. A transparent billing and pricing system could help them to reduce this burden.
- Location: tractor owners usually work with their machinery in 20 Km radius, therefore, they are likely to choose one of the contractual arrangements that are available in their area.

- Profitability: tractor owners select a contractual arrangement which allows them to maintain a profitable business, in which they are able to cover operational costs and obtain some return.

Transaction costs

The most relevant transaction costs are analyzed for the users and providers of the service, following the definitions used in section 4.1.

Contractual arrangements

As suggested by Wander, Birner, & Wittmer (2003), the contractual arrangements refer to all the transactions between farmers and other agents which allow providing mechanization services.

The information collected in the study area suggests that there are currently four main contractual arrangements that farmers can use to hire mechanization services:

1. EM3 Agri Services: with 29 operative CHC, it is the newest contractor in the study area. It is currently facing a developing stage and is aiming to develop more CHC in order to increase its reach. A detailed description can be found in section 5.1.
2. Informal sharing: refers to the traditional sharing of machinery between farmers from the same area. It usually takes place without an organized structure and relies strongly on personal connections.
3. Contractors: it is the most common option for mechanization service provision. Private tractor owners offer their services to old and new customers in exchange for payment.
4. Farmer groups: when farmers are members of a farmer's organization, they can access mechanization services through equipment owned by the organization. Usually, this contractual arrangement is limited to basic activities.

5. RESULTS

5.1 EM3 Agri Services business model

5.1.1 EM3 Agri Services Profile

EM3 Agri Services is an Indian start-up company that provides tractor services on a pay-per-use basis. Founded in 2014, it is India's first provider of an ICT-driven model of farm services and it is referred to as "the Uber for agriculture"(Business Today, 2017). According to the media (Business Today, 2017; New York Times, 2016; The Economic Times, 2017), one of the innovations of this company's business model is the operation of a mobile app through which farmers can place orders for renting farm equipment and services for the entire cultivation cycle (EM3 Agri Services, 2017). As of September 2017, EM3 claimed to have provided over 50,000 hours of operation to approximately 12,000 farmers in its network in India (Empea Institute, 2017).

The company was created to promote new alternatives to the traditional way of tractor service provision in India, which remains unorganized, dominated by private contractors and government centers with limited equipment and reach (The Economic Times, 2016a). In this context, EM3 Agri Services emerged with the goal of formulating a solution to improve farmers' access to tractor services in an efficient and affordable way. Founded by Rohtash Mal (a former executive in agricultural mechanization, automobiles, telecom, and retail) (Bloomberg, 2018) and his son Adwitiya Mal, the start-up seeks to innovate the way farming is done in India inspired by the business approach developed by firms like Uber (The Economic Times, 2016a). In 2014, this start-up started operating in Madhya Pradesh, and in the last 4 years, it has extended its work to Rajasthan, Uttar Pradesh, and Gujarat.

5.1.2 Agreement with the Government of Rajasthan

In November 2016, the Government of Rajasthan (GOR) signed an agreement with EM3, TAFE, and Mahindra & Mahindra to set up, launch, operationalize, supervise and certify Custom Hiring Centers (CHC) across Rajasthan. In this context, EM3 is responsible for establishing 300 centers to provide mechanization services to 100,000 farmers in 28 districts of the state (Business Today, 2017). According to documentation owned by EM3, the main objectives of this agreement are:

i. Enabling farmers with a set of farm machinery, implements, and equipment operated by trained operators meant for pay-per-use by farmers.
ii. Promoting local entrepreneurship in CHC-based agri-enterprises and create employment for rural youth.

The companies are free to develop a business model that allows them to implement and develop CHC across Rajasthan. EM3 works with different business models in the states where it operates. In the case of Rajasthan, the start-up has decided to work with a franchise model to procure the equipment required to fill the existing machinery and technology gaps in the state.

In order to implement the franchise model, the company has the following key guidelines:

1. The project should have a value between one and ten million rupees (between 12,500 and 125,00 Euros approximately).
2. The CHC should have at least one implement for the five stages of the crop cycle (land preparation, sowing, crop care, harvesting, and postharvest).
3. A subsidy of 40 percent on the purchase value of tractor or implements (exclusive of taxes) will be given to entrepreneurs who set up a CHC.
4. According to the agreement, the subsidy gets released between 30 and 90 days from the date the contract is subscribed.
5. The franchisee must mandatorily provide a minimum of 650 hours of custom hiring service per machinery per year, for a total duration of 7 years.

5.1.3 The establishment of EM3 Custom Hiring Centers under the franchise model

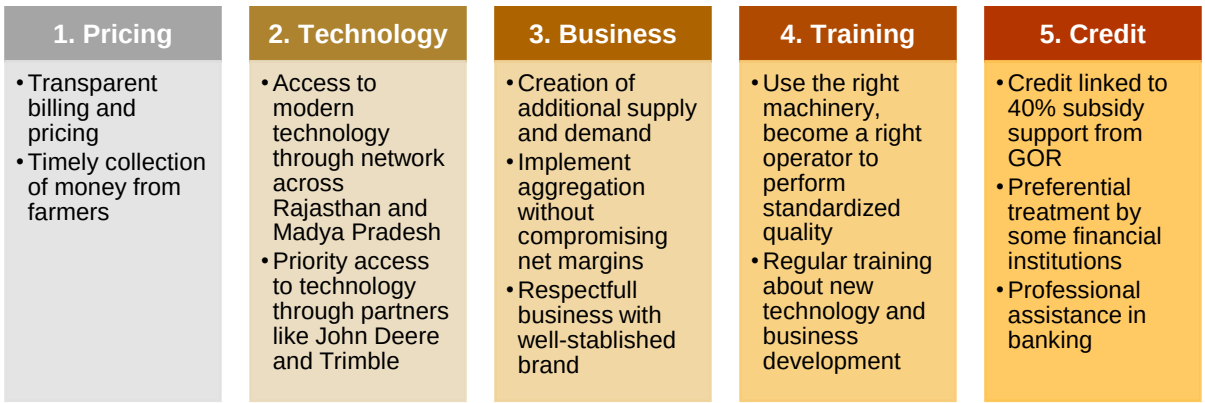
To establish a CHC, EM3 usually evaluates the potential of the area and determines if the business model could generate a win-win situation for the farmer, the tractor owner, and the company. For this reason, EM3 usually conducts short surveys and interviews in the areas of potential intervention following these criteria:

Figure 9. Pre-evaluation for EM3 CHC establishment

Source: EM3 Agri Services

1. *Level of mechanization:* EM3 estimates the number, the type, and the age of the machinery in the area and whether additional equipment is demanded. In this way, the company can determine if working in the area is suitable and whether there is a mechanization gap.
2. *Crops grown:* the production of the main crops is analyzed to establish the type of machinery that farmers in the area require. In addition, special attention is given to the profitability of the crops for the farmer since this can determine whether he or she will be able to pay for the service. Usually, crops which have a minimum price established by the Government are preferred. The targeted crops in Rajasthan are soya, paddy, urad, and maize for Kharif; and wheat, mustard, gram, coriander, and garlic for Rabi.
3. *Level of irrigation:* access to irrigation is evaluated to determine the productivity in the area and to assess the potential impact of mechanization.
4. *Landholding:* taking into consideration the small holding size in India, EM3 estimates whether the landholding size in the area is suitable for mechanization and whether it is profitable for the tractor owner to provide mechanization services.
5. *Operational costs:* costs of maintenance, diesel, electricity, transportation and operational costs of the CHC need to be estimated to analyze the profitability of the franchise.
6. *Willingness from farmers:* EM3 assesses the motivation and the willingness to pay from farmers in the area to evaluate whether the establishment of a CHC is suitable or not.

Figure 10. Advantages offered by EM3 to its Franchisees



Source: EM3 Agri Services

According to EM3, local entrepreneurs who decide to participate in the franchise model can have access to several benefits, compared to other mechanization providers (Figure 10):

1. Service providers have better conditions for the payment of their work. In fact, the platform developed by EM3 allows them to control the rate that should be charged for the service, considering the land size and the location of the farm. This increases transparency and allows the providers to have a timelier money collection.

2. Working with the franchise model enables them to access to technology. One of EM3's priorities is to make high technology equipment available for smallholder farmers, therefore, the company offers its franchisees access to state of the art equipment through the subsidy agreement with GOR.
3. The franchise model aims to create a more formal and structured market for mechanization services. In this sense, the company aims to allow tractor owners to transform occasional and local service provision into well-established business. By becoming a franchisee of EM3, local tractor owners can buy more pieces of equipment with a preferential price, and therefore offer more agricultural services. As a result, demand can also increase. Service providers can also offer additional services through the "aggregation" network of the company, which allows matching the farmers' equipment requirements with providers from other geographical areas.
4. EM3 aims to generate a standardized quality of its agricultural services by promoting training among its franchisees. The training includes features such as, learning the proper use of the machinery and managing their own business.
5. EM3 allows improving the franchisees' access to credit. A 40 percent subsidy for new agricultural equipment is available through the agreement between EM3 and GOR, which allows tractor owners to upgrade their business. Moreover, the agreement also allows them preferential treatment in some financial institutions and access to professional banking assistance.

Figure 11. Custom Hiring Center implemented by EM3 in Bikaner, Rajasthan

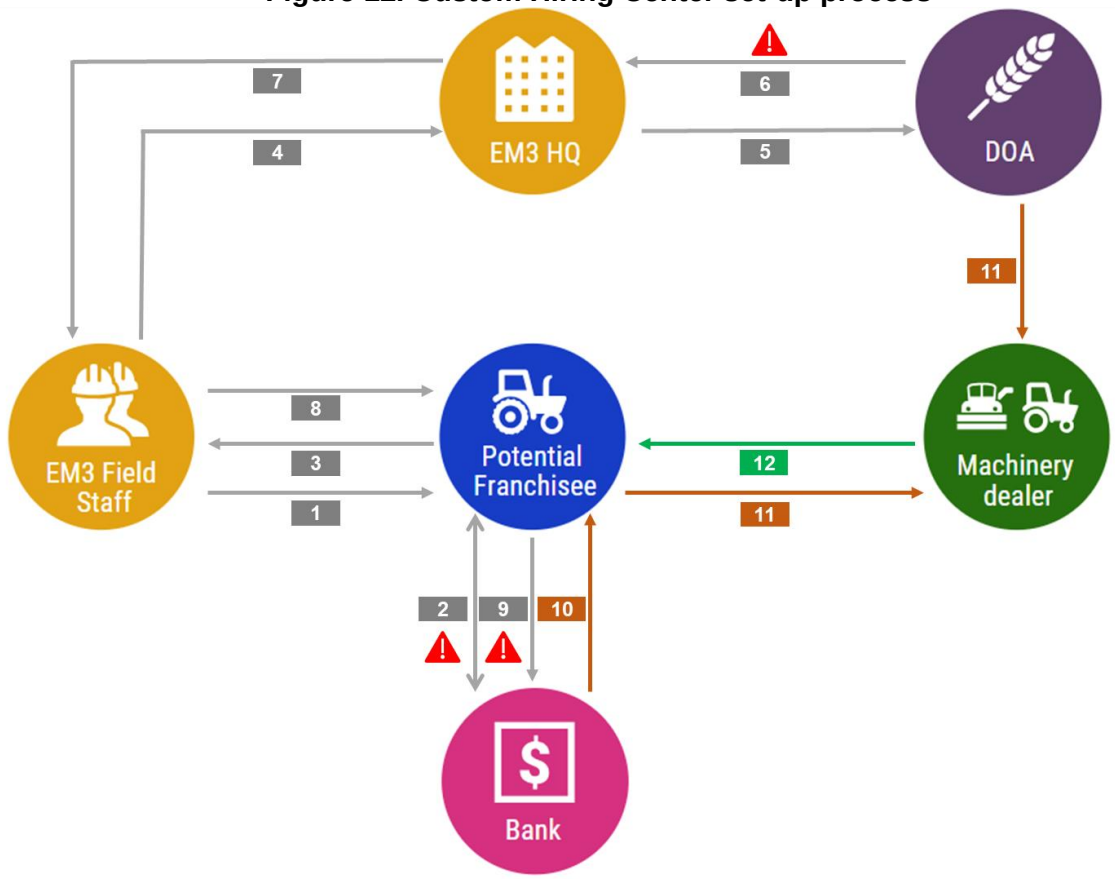
Source: The Author

In the same way, entrepreneurs who wish to set up a CHC with EM3 also need to fulfill some specific criteria:

1. The applicant needs to have a good bank repayment history.
2. He or she should have a good connection with at least a group of 500 farmers in the area. In this sense, previous mechanization service providers are strongly preferred.
3. The potential service provider must have good knowledge of the local geography (20 km radius), the crops grown, the machine usage, etc.
4. The applicant should be a reputable person in the area.
5. The potential provider must have at least 200,00 rupees to invest (approximately 2,500 Euros).

If the pre-evaluation of an area shows that there is a potential to establish EM3 CHCs, the company starts looking for entrepreneurs who could be interested in setting up one of the franchisees. Potential candidates usually include local mechanization providers (who typically have 1 or 2 tractors and basic implements), owners of agricultural inputs stores, and medium and large farmers (who frequently own a holding larger than 5 hectares and basic machinery). Once the entrepreneurs have been identified, a complex process follows to set up a CHC, in which several stakeholders are involved (Figure 12).

Figure 12. Custom Hiring Center set-up process



Grey arrows are used to represent the information/request flows; orange arrows are used to show money flows, and green arrows are used to show the machinery/equipment flow. Exclamation sings are used to show bottlenecks and points in which the flow could be stopped.

Source: The Author

(1) In the first step, EM3 Field Staff discusses with the potential franchisee the benefits of working as a part of the company's network. If the entrepreneur accepts to participate, then he or she meets bank representatives together with EM3 Field Staff to have a general understanding of the value of the project and the financing conditions (2). The bank also analyzes the credit history of the entrepreneur and evaluates whether he or she can have access to a loan for agricultural machinery. If there is a positive answer from the bank, the potential franchisee officially submits the application file[4] to EM3 Field Staff (3), which is then sent to EM3 Headquarters (HQ) in Jaipur (4). The application file is checked, and if is complete it is sent to the Department of Agriculture (DOA) office in Jaipur (5). This governmental office oversees if the applicant will be able to fulfill the requirements stated in Figure 5 (area, capacity, entrepreneurship, local requirements). Once the file has been approved by the DOA, it is sent back to EM3 HQ (6), EM3 Field Staff (7), and to the applicant (8). The entrepreneur then needs to go again to the bank with the approval from DOA and the application file for EM3 in order to negotiate and sign the loan contract (9). Upon approval and verification of the file, the loan is transferred to the applicant's bank account to establish the CHC (10). The applicant is then able to pay for the agricultural machinery he or she wants to buy and also does the DOA, which transfers the 40 percent subsidy to the machinery dealer (11). Finally, the machinery dealer provides the equipment to the applicant (12).

5.1.4 EM3 business model and the ICT-based service of mechanization provision

The above-described business model has been implemented since 2017 across Rajasthan, and the first CHC started operating in March 2018. This section describes how the service is provided in the field by displaying four different figures about the request process, the on-farm service provision of mechanization, the payment flow, and the feedback and complains flow.

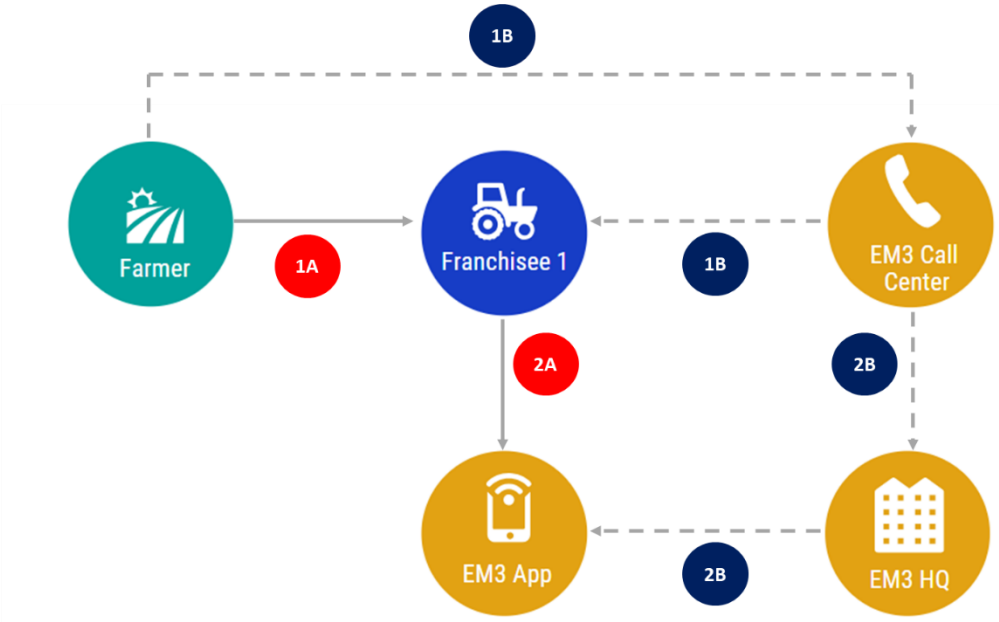
Figure 13 displays the process of request for machinery services that the farmers need to undertake in order to hire one of the franchisees. The request for mechanization services starts when the farmer reaches either one of the franchisees directly (1A) or when he or she reaches EM3 Call Center (1B). In many cases, the person managing one of the Franchisees was a contractor in the area, therefore, there is a previous work relationship between the farmer and the franchisee. When this is the case, the farmers typically prefer to contact the franchisee directly by a phone call. Once the request has been done to the franchisee, the CHC must upload the farmer's request on EM3's app (2A). In this platform, the request gets a specific code, in which the farmer's name, the landholding size[5], the type of agricultural equipment

[4] The most important documents required for a Franchisee application are: EM3 application form, proof of identity, a project report (location map, list of equipment and price), caste certificate, and contract to work as CHC (which states that the franchisee will provide custom hiring services for 6 years).

[5] In most of the cases, when farmers request EM3's service for the first time, members of EM3 Field Staff visit the farm to confirm its location and to measure the size of the landholding using mobile tools. This information is used later to estimate the time and the price of the service.

required, and the date of the request must be introduced. Alternatively, in cases when farmers do not previously know the local franchisee, they reach EM3 call center and place their request (1B). When this is the case, the call center contacts EM3 Headquarters (HQ) in Jaipur to upload the request's information on the platform (2B).

Figure 13. The request process for EM3 users and franchisees



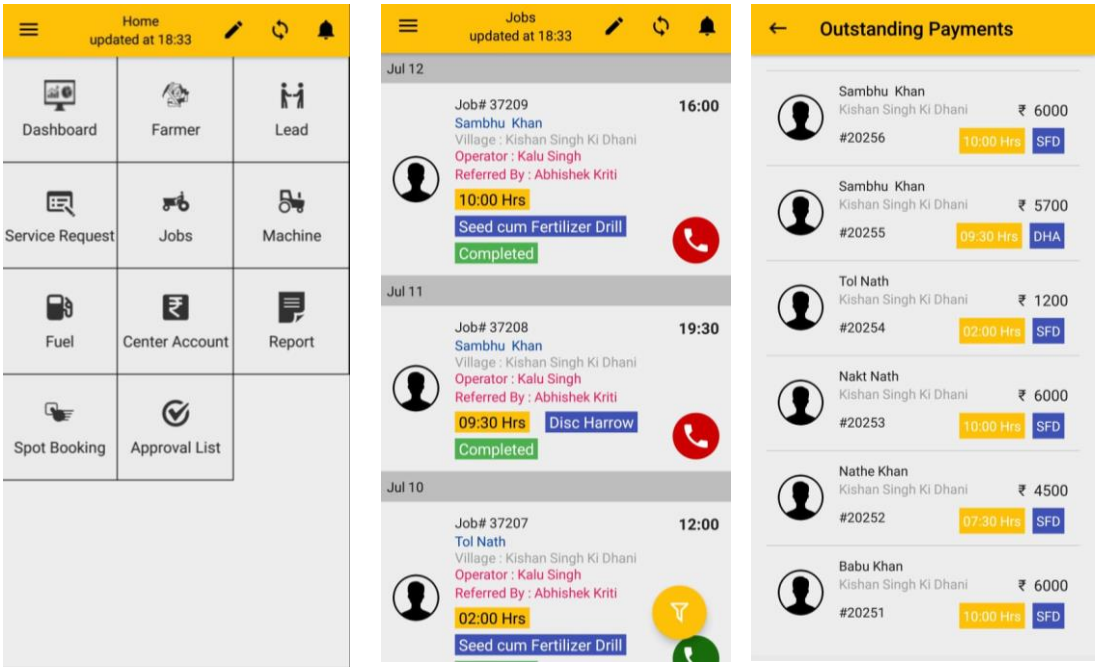
Source: The Author

In this point, it is important to mention that although a lot of attention has been given to this business model by the media because of its mobile-tool-based nature, the digital platform that EM3 is developing is working partially. In fact, the app that is supposed to match the farmers with the tractor providers is still being developed and, therefore, the request process can still not be done directly by the farmers through the app. Nevertheless, what EM3 has successfully developed is an app and digital platform that allows connecting the franchisees across Rajasthan with the headquarters located in Jaipur. As displayed in figure 14, this platform allows to control the following information:

- The request status: whether the request has been completed.
- Type of equipment: agricultural machinery required by the farmer for a specific activity.
- Name of the farmer.
- Name of the operator: the tractor operator can either be the franchise owner or an operator hired by him.
- Price: the price to be charged by the operator is displayed, which is based on the local market of that machinery.

- Payment status: whether the service has i) already been paid by the farmer, and ii) paid by the franchisee to EM3 Headquarters[6].

Figure 14. EM3 App that connects headquarters with franchisees

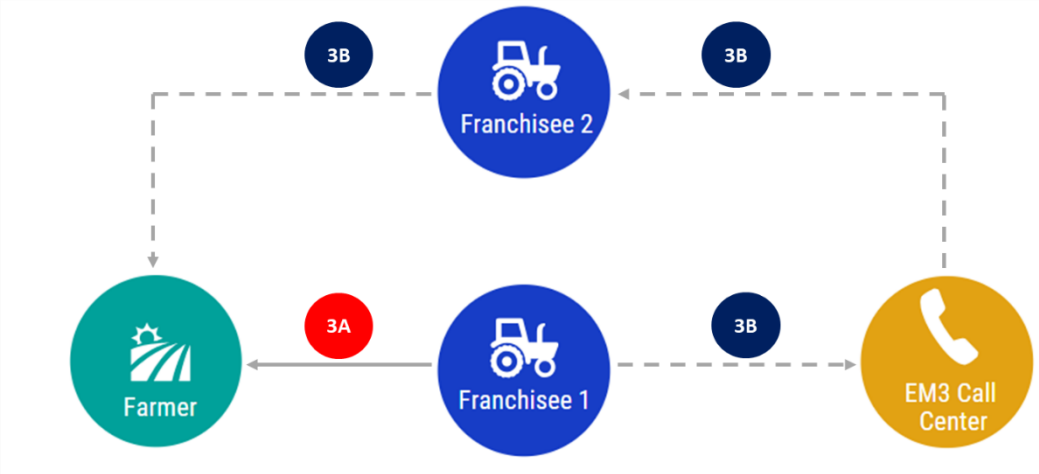


Source: EM3 Agri Services

The second stage of the service provision takes place when the operator comes to the farm with the equipment required by the farmer, as shown in Figure 15. Typically, farmers hire the service from an operator they already know, and in many cases, farmers are also familiar with the type of machinery that the local franchisee owns. When this is the case, the franchisee comes to the farm with the machinery requested (3A). Alternatively, one of the innovations of the business model implemented by EM3 is the *aggregation* of farm mechanization services. This allows farmers to have access to agricultural equipment that the local franchisee does not own, by contacting other franchisees or tractor operators from other areas who own this equipment. When aggregation is required (3B), the local franchisee directs the request to EM3 Call Center, and then another franchisee or independent contractor is contacted to provide the service. After this, the franchisee that owns the machinery required comes to the farm to provide the service. This approach is frequently used for the most expensive and specific machinery, such as rice transplanter, laser land leveler, and combine harvesters.

[6] The model used for the franchisees' payment to EM3 Headquarters is described in Figure 16.

Figure 15. Service Provision scheme by EM3's franchisees

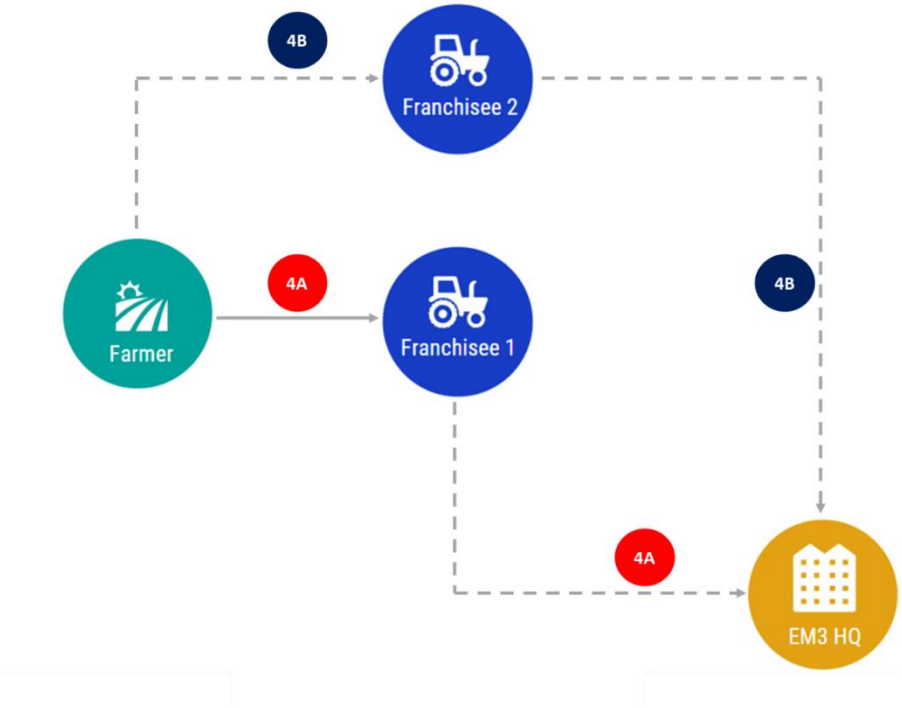


Source: The Author

For instance, EM3 used this model for the first time in Rajasthan for wheat harvest during Rabi in 2018. Independent combine-harvester operators from Punjab were contacted by EM3 to provide harvest services to farmers in different areas, which allowed a better planned and timely service provision.

The third stage is the payment of the service, which is shown in Figure 16. The farmer has the option to pay in cash or to transfer the money to the franchisee. This can be done on spot, right after the service was provided, or within 15 days. After this, the franchise has to pay a 5 percent commission to EM3 headquarters for the use of the platform (4A). The payment is done once per month and represents 5 percent of the total value revenue generated by the franchise. The franchisees' incentive to report their requests and transactions on the platform is related to the fulfillment of the 650 hours of farm work that each piece of equipment needs to achieve. Additionally, if aggregation was used for the service provision, franchisee two collects the money from the farmer and then transfers the 5 percent commission to EM3 Headquarters (4B).

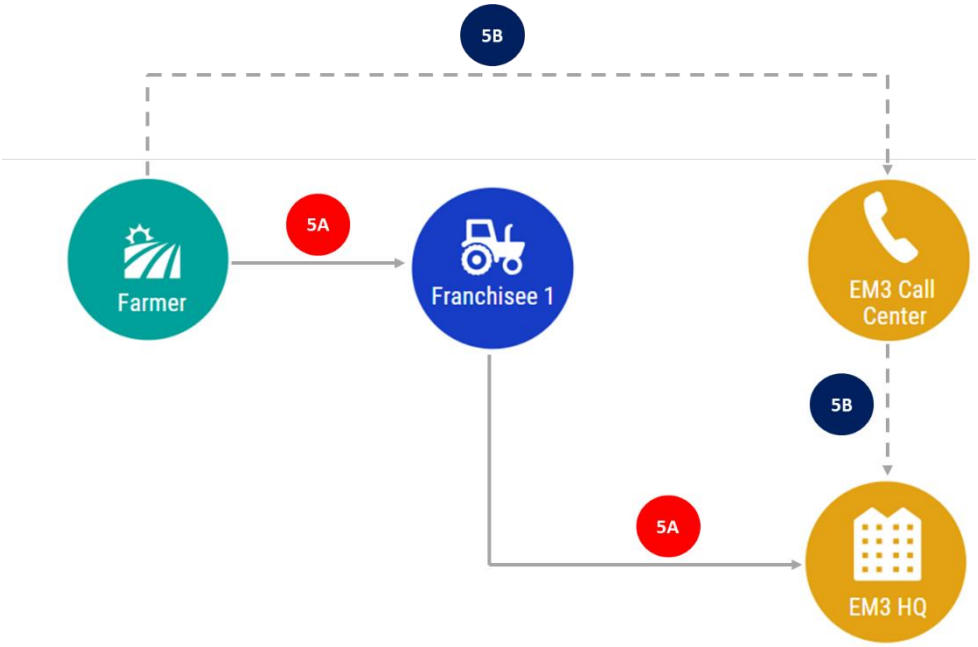
Figure 16. Payment flow in EM3 franchise model



Source: The Author

Finally, the last step is the flow of feedback or complains about the service, which is displayed in Figure 17. Since the app developed by EM3 still does not allow direct contact between the farmers, the franchisees, and EM3 Headquarters, this flow remains limited. Nonetheless, if the farmers would like to give feedback about the service, they can do it through the franchisee (5A), who is supposed to report it to the Headquarters. Alternatively, they can also give their feedback directly to the company by reaching the call center (5B). This information flow has been useful to transmit new equipment needs from the farmers to the franchisees and the headquarters. In addition, information about new possible locations to implement the business model, and potential applicants for the franchise model has been transmitted from the farmers to EM3 Field Staff.

Figure 17. Feedback/complains flow in EM3 franchise model



Source: The Author

5.1.5 Terms and Conditions for CHC

To guarantee the proper functioning of the business model, EM3 and the franchisees must accomplish certain criteria which allow controlling the correct use of the machinery and the fulfillment of the agreement. In the next points, the most essential conditions for the machinery management and the service provision between EM3 and its franchisees are described.

Machinery management

1. The franchisee must ensure the usage of all assets by a person with a valid driving license.
2. The cost of maintenance and service is born by the franchisee.
3. The franchisees should install a GPS device on their tractors in order to allow proper tracking. The approximate cost of these devices is between 5000 to 7000 rupees (60 and 80 Euros).
4. All the farm machinery should be procured from the original equipment manufacturer.
5. The franchisee cannot sell the farm machinery to any third party for the duration of the agreement.
6. The franchisee guarantees that the farm machinery is not used for any other purpose than for providing services to the customers of EM3.

Service provision

1. The agreement has a term of 7 years. Nonetheless, the franchise should at least remain fully and properly functional for at least 4 years.
2. The franchisee must maintain a monthly performance report and bank account for the CHC.
3. The franchisee needs to furnish a Security Deposit to EM3, which will be used as an indemnification in case of losses, sanction, or penalties imposed by the company, the government, or any other institution. The value of the security deposit varies depending on the capital expenditure incurred by the franchisee[7]. The security deposit is returned to the franchisee along with simple interest at the termination of the agreement.
4. A minimum of 650 hours per year per tractor should be provided by every subsidized tractor available in the CHC. If 50 percent or more of the subsidized tractors available fail to meet the minimum requirement of hours, EM3 will consider it as non-performing CHC under the agreement. In this case, EM3 deducts a percentage of the security deposit.

5.2 Evaluation of access to mechanization services and ICT in the study area

Once EM3's business model and operation on the filed have been described, this subsection focuses on the evaluation of the access to mechanization services of the farmers in the study area. The main findings regarding the contextual factors of the users are analyzed, in which socio-economic factors, production system factors, access to ICT, and agricultural mechanization are assessed. A comparison of the performance of the different contractual arrangements is presented based on the quantitative data collected through the survey of 101 households which use mechanization services in Bundi and Kota.

5.2.1 Socio-Economic Factors

The main information about the socio-economic factors of the households surveyed is displayed in Tables 7 and 8. As stated in section 3.2.1, Bundi and Kota districts were selected for methodological purposes, and among the study sample, 36 percent of the households were located in Kota and 64 percent in Bundi. All the households' heads surveyed were males, and only 3 percent of them claimed to belong to an organization, which in all the cases referred to a farmer-based organization.

[7] The security deposit is equivalent to 2 percent of the total investment if the capital expenditure stands between INR 1 million and 2.5 million; 1,5 percent if the capital expenditure stands between INR 2.5 million and 5 million; and 1 percent if the capital expenditure stands between INR 5 million and 10 million.

Table 7. Main nominal variables for farmers' socio-economic factors

Variable	Categories	Percentage
District	Kota	36%
	Bundi	64%
Gender of Household head	Male	100%
	Female	0%
Member of an organization	Yes	3%
	No	97%
Off-farm income	Yes	20%
	No	80%
Education of household head	No formal education	6%
	Primary school	9%
	Middle school	19%
	Secondary school	23%
	Higher secondary school	28%
	Graduation	14%
	Post-Graduation	2%

Source: The Author

Regarding the main sources of income, 80 percent of the households rely on farming as their only source of income, while 20 percent of the households generate off-farm income. The most common activities which contribute to the household's income are related to casual and permanent nonagricultural employment, and the provision of mechanization services to other farmers. In what refers to education, 6 percent of the respondents did not have formal education, and 9 percent completed primary school. Moreover, 85 percent of the respondents continued school after primary school, nonetheless, only 16 percent of them was able to obtain a university degree or higher.

Table 8 shows additional information regarding the general characteristics of the households surveyed. The average age of the household heads is 44 years old. Only 8 percent of them are 30 years old or younger, while 20 percent are older than 50. In addition, the average household in the study sample has 6.11 members and operates a landholding of 4,99 hectares. In this point, it is important to mention that the study sample refers to farmers who used agricultural mechanization in the last year, therefore, the land cultivated by the households reflects a higher average than the national and the state average.

Table 8. Main ratio variables for farmers' socio-economic factors

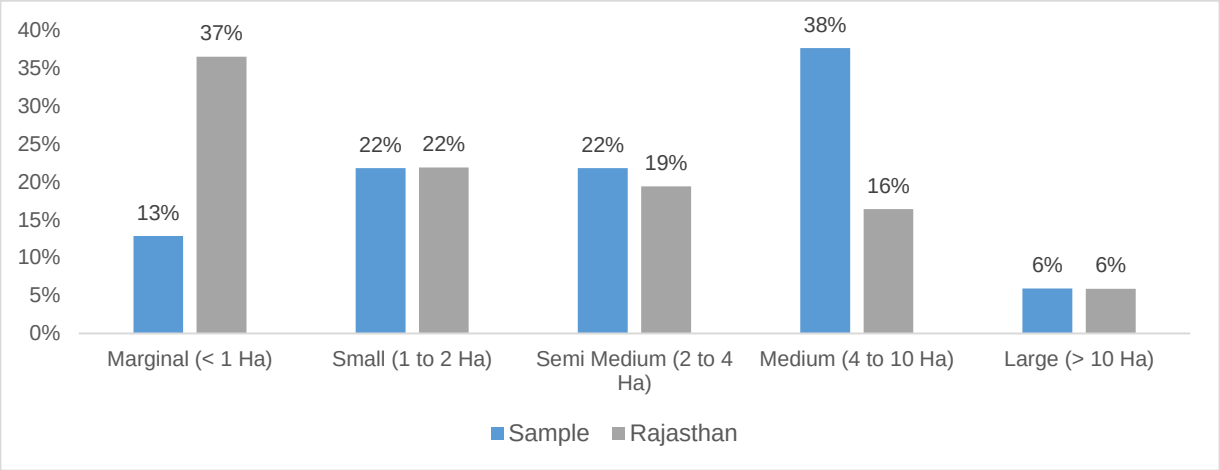
Variable	N	Mean	Min	Max	SD
Household head age *(years)*	101	43,96	24	65	9,12
Household size *(members)*	101	6,11	3	17	2,21
Land cultivated *(Ha)*	101	4,99	0,33	80,94	8,91

Source: The Author

5.2.2 Production system factors

In order to assess the main characteristics of the production systems in the area, the size of the landholdings and the crops produced are described in this section. First, the size of the agricultural operational holdings in the sample is presented in Figure 18. The data shows a different distribution among two of the landholding categories when compared to the average in Rajasthan. In fact, marginal farmers from the sample represent 13 percent of the total landholding, while in the state average they represent 37 percent. In the same way, medium farmers from the sample represent a category 22 percent larger than the average in Rajasthan. This difference can be attributed to the sampling methodology applied for the objective of the study, which focuses only on farmers who are users of agricultural machinery. The other categories show similar shares as the ones at the state level.

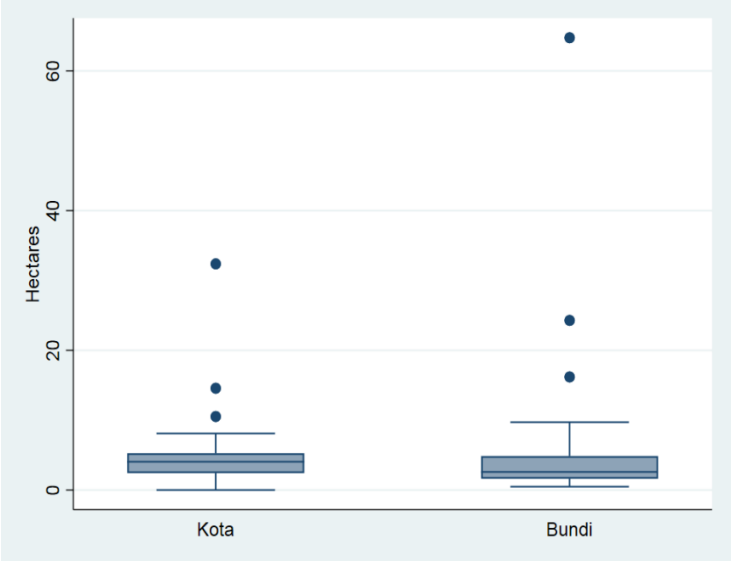
Figure 18. Landholding in the study sample and in Rajasthan



Source: Department of Agriculture Rajasthan (2011), the Author.

Additionally, when analyzed at the district level (Figure 19), landholding in Kota shows a median landholding of 4,04 Ha, while the median in Bundi is 2,59 Ha. It is noteworthy, that in both cases large farmers are displayed as outliers among the study sample.

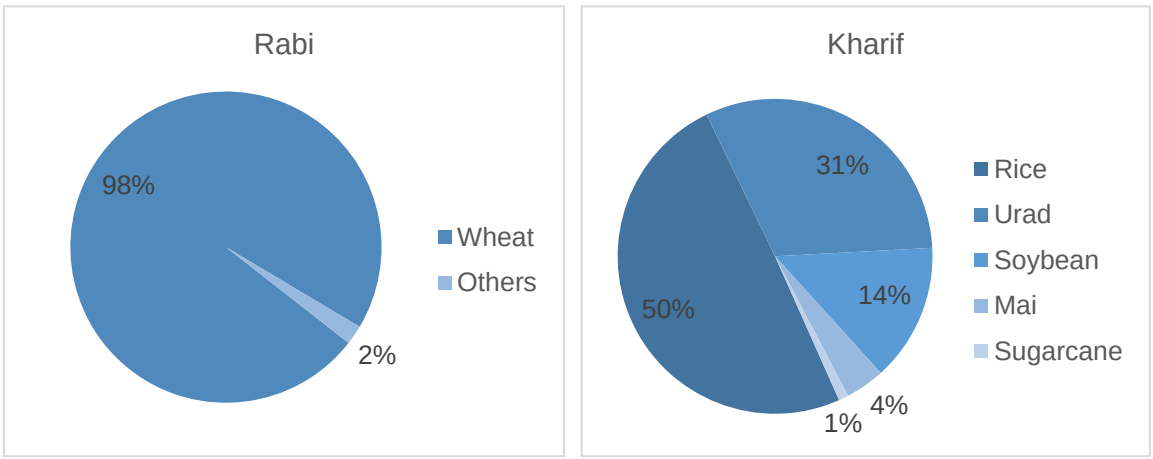
Figure 19. Landholding per district in the study sample



Source: The Author

When analyzed by seasons, the agricultural production in Rabi displays a high dependence on wheat, which is the preferred crop by 98 percent of the households. This is mainly due to the application of a minimum price for this crop by the government, which ensures a profit for the farmers. In contrast, in Kharif, there is a larger diversification of crop production. Rice is the most extensive crop, which is grown by 50 percent of the households. Furthermore, urad, soybean, and mai are also commonly grown in the area.

Figure 20. Crops produced per season in the study sample



Source: The Author

5.2.3 Access to ICT

Access to mobile phones and the internet were used as a proxy for understanding the current use of ICT services among the households surveyed. In this context, Table 9 shows that 98 percent of the households own a mobile phone in the study area. Moreover, 60 percent of households have access to the internet, mainly through mobile broadband.

Table 9. Access to ICT for farmers in the study sample

Variable	Categories	Percentage
Access/ownership of a mobile phone	Yes	98%
	No	2%
Access to the internet	Yes	60%
	No	40%

Source: The Author

In addition, the use of smartphones was assessed in the study sample. In Table 10, it can be observed that 56 percent of the households either own or have access to a smartphone. Furthermore, only 23 percent of the marginal farmers and 27 percent of the small farmers use a smartphone, whereas 83 percent of the large farmers have access to it. Additionally, the chi-square test shows that the association between the size of the landholding and the use of a smartphone is statistically significant.

Table 10. Chi-squared test between the type of landholding and use of smartphone

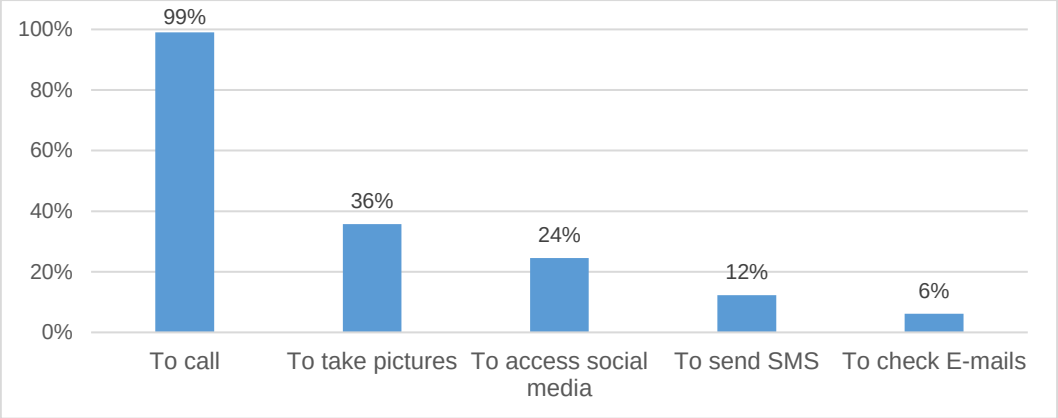
Landholding	Rate of smartphone use	n
Marginal (< 1 Ha)	23.08%	13
Small (1 to 2 Ha)	27.27%	22
Semi Medium (2 to 4 Ha)	59.09%	22
Medium (4 to 10 Ha)	78.95%	38
Large (> 10 Ha)	83.33%	6
TOTAL	**56.44%**	101
Pearson chi2(8) = 28.8590	**Pr = 0.000**	

Source: The Author

The data collected also enabled to identify the main reasons why the farmers decided not to use a smartphone. For 63 percent of the farmers, the most important reason was that they do not consider the smartphone to be useful. In the second place, 34 percent of the respondents acknowledged that they do not know how to use it. Furthermore, only 10 percent of the farmers claimed that they do not use a smartphone because they consider the price is too high and none of them considered the mobile broadband availability as a limitation in their area. In this sense, figure 21 shows that the use of mobile phones still remains limited to the most basic features. Indeed, when asked about the most important uses of the mobile phone, 99 percent of the respondents considered calling the most useful function. Taking pictures was considered

as the second most important use, with 36 percent, while accessing social media was third, with 24 percent.

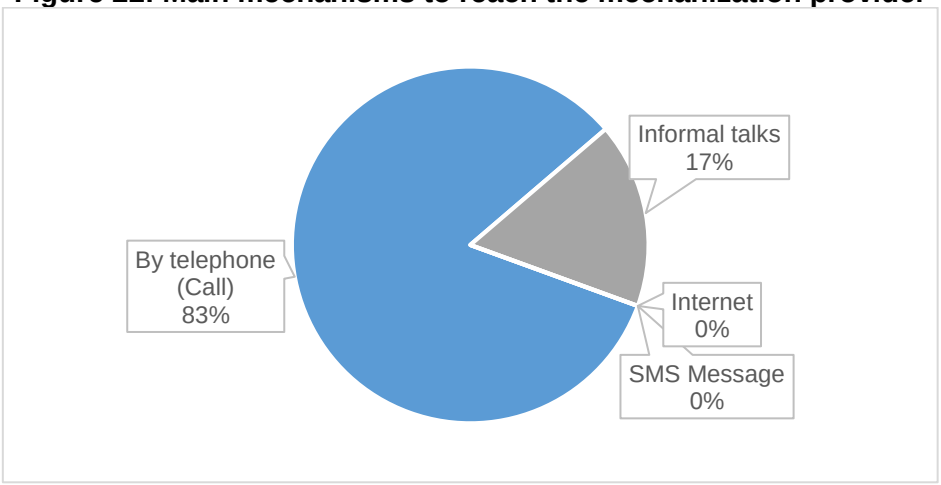
Figure 21. Main uses of mobile phones as reported by farmers in the study sample



Source: The Author

In order to relate the use of ICT with the provision of mechanization services in the study sample, farmers were asked about the main mechanisms they use to reach the mechanization providers (Figure 22). The results report that in 83 percent of the cases, farmers reach them by a telephone call, whereas in 17 percent of the cases they do it through informal talks with them. None of the respondents considered the internet or an SMS as an option to hire mechanization services in the last year.

Figure 22: Main mechanisms to reach the mechanization provider



Source: The Author

5.2.4 Agricultural mechanization

The use of agricultural mechanization in the study area is evaluated in two stages. In the first one, the degree of ownership of agricultural machinery is assessed, complemented by a brief analysis of the main equipment owned by the respondents. In the second stage, the hiring of mechanization services is evaluated in detail. The hiring of mechanization services is assessed by landholding categories, contractual arrangements, types of equipment contracted, and the price paid.

5.2.4.1 Ownership of agricultural machinery

Table 11 displays the main features regarding mechanization ownership in the study area. The table shows that 76 percent of the households own at least one piece of agricultural machinery. The degree of ownership varies across the different landholding categories, which reaches 39 percent for marginal farmers, 73 percent for the semi-medium farmers, and 100 percent for large farmers. Moreover, the Chi-square test shows that the null hypothesis of independence between the size of the landholding and the ownership of agricultural machinery should be rejected. In other words, this suggests that there is a statistically significant association between the size of the landholdings and the ownership of agricultural machinery.

Table 11. Chi-squared test between the type of landholding and machinery ownership in the study sample

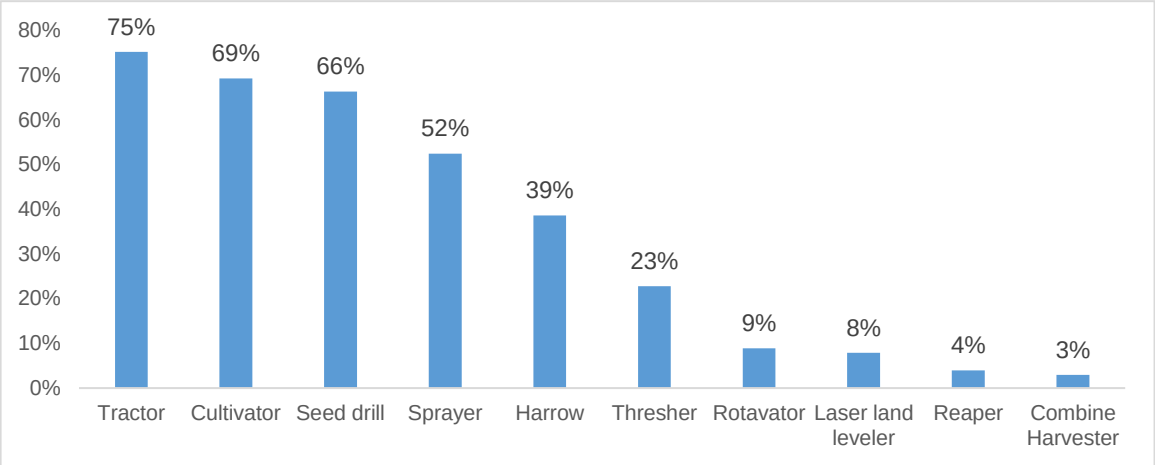
Landholding	Agricultural machinery ownership in the household		
	Yes	**No**	**Total**
Marginal (< 1 Ha)	5	8	13
	38.46%	61.54%	100%
Small (1 to 2 Ha)	14	8	22
	63.64%	36.36%	100%
Semi Medium (2 to 4 Ha)	16	6	22
	72.73%	27.27%	100%
Medium (4 to 10 Ha)	33	2	38
	94.74%	5.26%	100%
Large (> 10 Ha)	6	0	6
	100.00%	0%	100%
TOTAL	**77**	**24**	**101**
	76.24%	**23.76%**	**100%**
Pearson chi2(4) = 21.3670 Pr = 0.000			

Source: The Author

In what refers to the type of agricultural machinery owned by the farmers (Figure 23), tractor, cultivator, and seed drill are the pieces of equipment most commonly owned by farmers in the area. In the case of the tractor, for example, 60 percent of the farmers decided to buy it in order

to expand and scale up farming, while 21 percent did it to improve farm timeliness, and 13 percent to save time. In comparison, only 3 percent did it in order to be independent, and 1 percent to provide mechanization services.

Figure 23. Percentage of farmers who own agricultural machinery, per type of equipment



Source: The Author

5.2.4.2 Hiring of agricultural machinery

For the second stage of the analysis, Table 12 presents general information regarding the hiring of mechanization services by the type of landholding. First, the data shows that in the study sample 75 percent of the farmers hired mechanization services in the last year (October 2017 to September 2018). In addition, when evaluating the proportion of mechanization services hired by each category of farmers, it can be seen that all the marginal farmers have hired mechanization services in the last year. Furthermore, 81 percent of the small farmers and 73 percent of the semi medium farmers hired mechanization services in the last year. For medium and large farmers, the rate reaches 66 and 67 percent. The data shows a trend in which the larger the landholding is, the fewer mechanization services it hires. This is essentially due to the highest ownership rate of machinery displayed by the largest landholdings. Nonetheless, the Chi-squared test suggests that this association is not statistically significant. Moreover, according to the data collected, the main reasons why farmers decided to hire mechanization services in the last year are related to (1) improvement of timeliness, (2) reduction of effort, and (3) both the enhancement of farm yields and labor shortages.

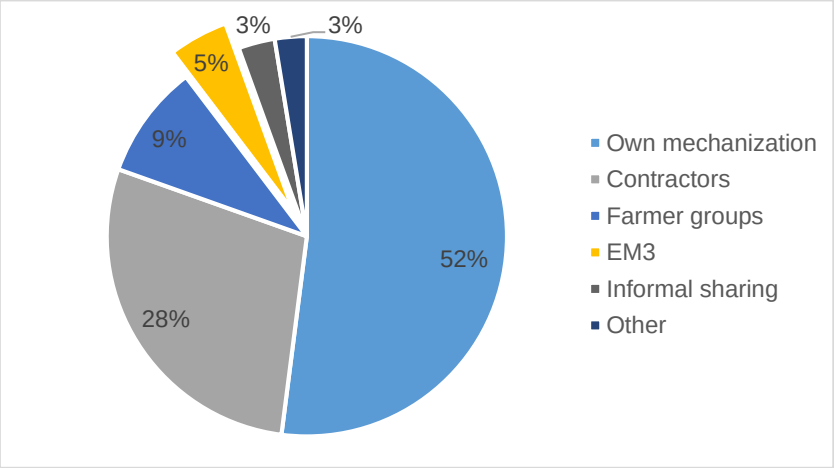
Table 12. Chi-squared test between the type of landholding and hiring of mechanization services in the study sample

Landholding	Hiring of mechanization services in the last year		
	Yes	No	Total
Marginal (< 1 Ha)	13	0	13
	100	0	100
Small (1 to 2 Ha)	18	4	22
	81.82	18.18	100
Semi Medium (2 to 4 Ha)	16	6	22
	72.73	27.27	100
Medium (4 to 10 Ha)	25	13	38
	65.79	34.21	100
Large (> 10 Ha)	4	2	6
	66.67	33.33	100
TOTAL	**76**	**25**	**101**
	75.25	**24.75**	**100**
Pearson chi2(4) = 6.9235		**Pr = 0.140**	

Source: The Author

As mentioned in section 3.6, farmers in the area can access mechanization services through different contractual arrangements. In this sense, it is noteworthy that depending on the type of crops produced, the stage of production, or the machinery required, a household may use different contractual arrangements during the same season. Therefore, in order to examine the data regarding the access to mechanization services in more detail, the units of analysis selected are the transactions. In total, the 101 households surveyed undertook 271 different transactions for mechanization hiring purposes.

Figure 24. Share of contractual arrangements for the provision of mechanization services in the study area

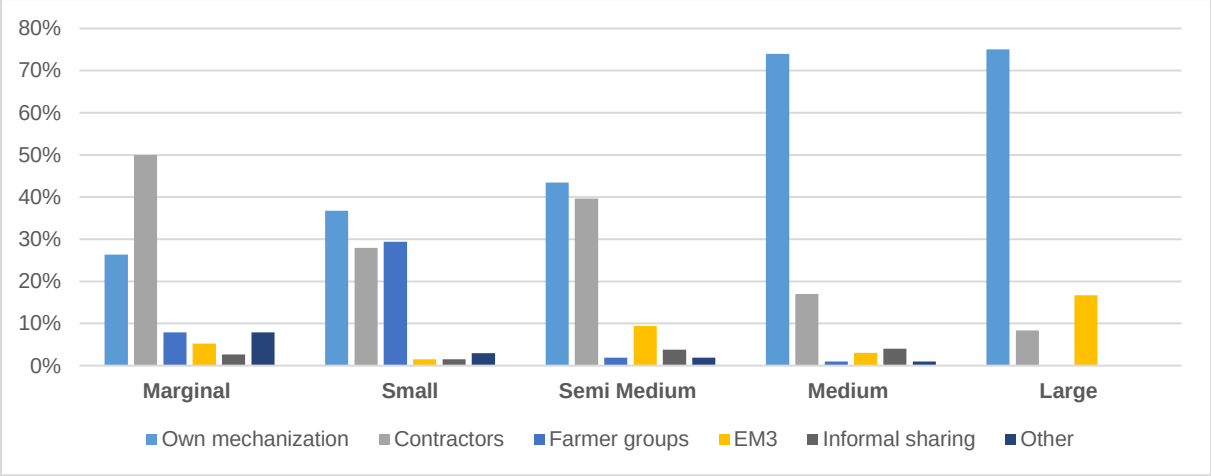


Source: The Author

Figure 24 compiles the information regarding the participation in the market of the contractual arrangements available. The data collected suggests that in 52 percent of the cases, farmers used their own machinery. Moreover, there are four main types of contractual arrangements available in the area which allowed farmers to access mechanization services. The most common among them are contractors, who were hired in 28 percent of the transactions, followed by farmer groups, who provided services in 9 percent of the transactions. EM3 Agri Services was the provider for 5 of the transactions, while informal sharing represented 3 percent.

In addition, the data allowed to assess the contractual arrangements selected by the different categories of landholdings in the study sample. In Figure 25, it can be observed that overall, own mechanization and contractors together account for at least 70 to 80 percent of the transactions of the farmers in each one of the categories. For marginal farmers, contractors represent the most important way of accessing mechanization services, with a share of 50 percent. For small farmers, the number of transactions with own mechanization, contractors, and farmer groups is relatively similar, with roughly 30 percent each. Semi-medium farmers mainly use own mechanization and contractors in order to satisfy their mechanization needs. Medium and large farmers use primarily own mechanization, with limited reliance on contractors for some activities. In this point, it is important to mention that, according to the sample, EM3's highest share of transactions corresponds to large farmers, with 17 percent. In contrast, marginal and small farmers have only hired EM3 in 5 percent and 1 percent of the transactions, respectively

Figure 25. Provision of mechanization services by type of landholding and contractual arrangement



Source: The Author

Furthermore, 5 types of machinery were the most frequently hired by the farmers: combine harvesters, seed drills, cultivators, sprayers, and tractors. In table 13, the share of the contractual arrangements chosen to hire each type of machinery is displayed. First, the data suggest that combine harvesters are the most demanded machinery, considering that 21 percent of the households have hired them during the period of analysis. Nevertheless, considering that only 3 percent of the farmers own a combine harvester, it can be stated that roughly a quarter of the farmers currently have access to a combine harvester. In contrast, the data show that for the other types of machinery the overall use is considerably high. In fact, when the percentage of ownership and hiring is measured for every type of machinery, it can be seen that the share of use among the farmers reaches between 60 to 85 percent. For example, the use of seed drill among farmers reaches 86 percent when the rate of ownership and hiring are added.

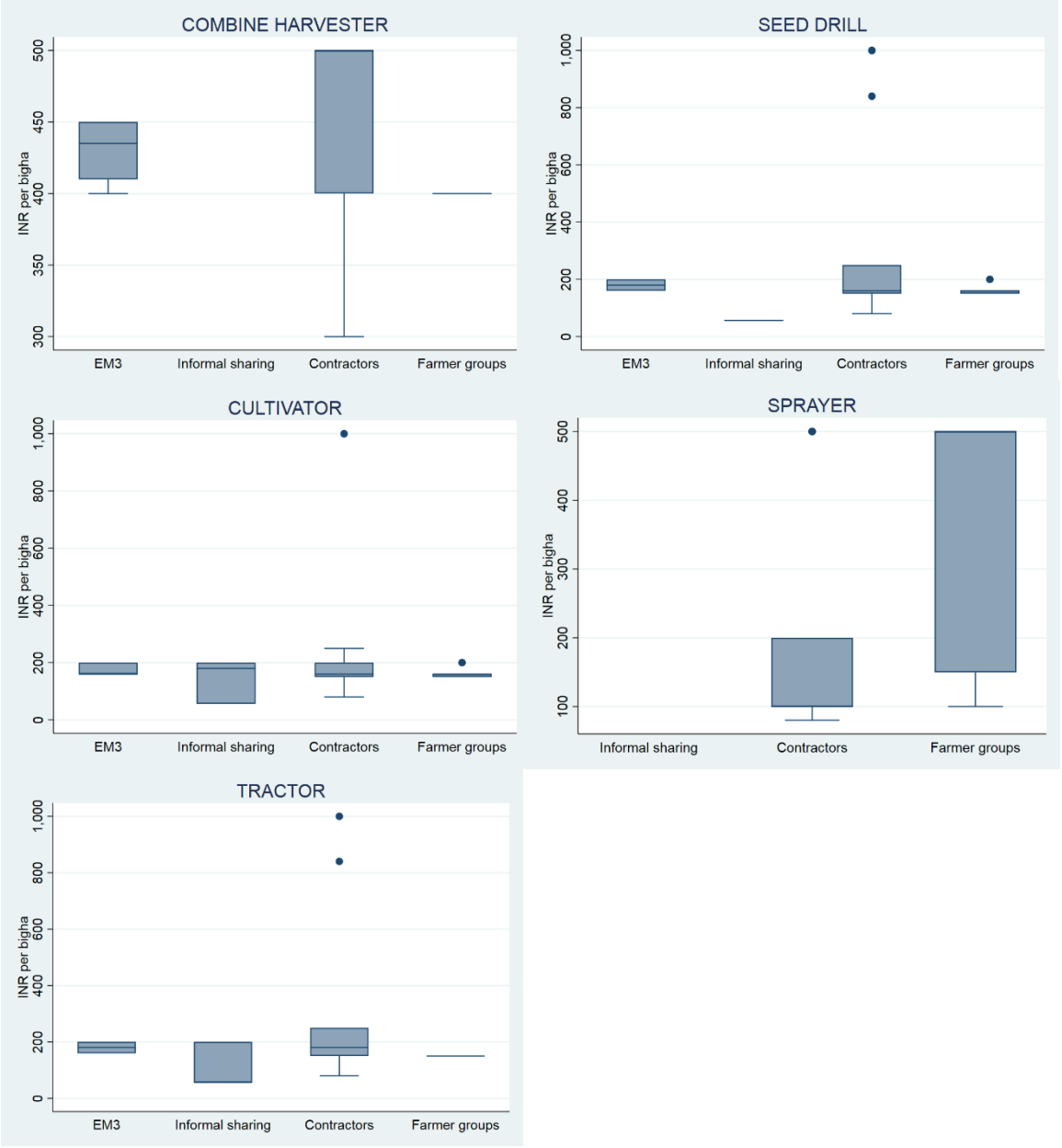
Table 13. Share of the contractual arrangement chosen by the farmers for the top 5 types of machinery hired

	Machinery	% Farmers own	% Farmers hire	Providers of agricultural machinery			
				Contractors	EM3	Farmer groups	Informal sharing
1	Combine harvester	3.0	21.0	82.9	11.4	2.9	2.9
2	Seed drill	66.3	20.0	56.3	12.5	21.9	9.4
3	Cultivator	69.3	15.0	48.0	12.0	24.0	16.0
4	Sprayer	52.5	12.0	70.0	0.0	25.0	5.0
5	Tractor	75.3	10.0	58.8	11.8	5.9	23.5

Source: The Author

The analysis of the providers shows that, among the top 5 of types of machinery hired, contractors are preferred by most of the farmers. Nonetheless, the role of the other contractual arrangements varies depending on the type of machinery. Farmer groups seem to play an important role in basic mechanization activities since they concentrate more than 20 percent of the provision of the seed drill, sprayer, and cultivator. In the case of EM3, in spite of only representing 5 percent of the total transactions in the sample, the analysis of the top 5 machinery shows a higher hiring rate. Indeed, with the exception of the sprayer, for the other types of machinery EM3 concentrates approximately 12 percent of the transactions. This could show that the business model is correctly addressing the farmers' needs regarding the types of machinery required. Moreover, informal sharing displays a limited role for most of the top 5 of machinery hired, although it seems to be a common contractual arrangement for the provision of tractor services with 24 percent.

Figure 26. Price charged by different contractual arrangements for top 5 machinery



Source: The Author

The analysis of the most demanded machinery also allows evaluating whether there are differences in the price[8] of the mechanization services offered by the different contractual arrangements. In figure 26, the box plots show the differences in price for each one of the top 5 types of machinery hired in the area, along with their distributional characteristics by the provider. First, in the case of the combine harvester, it can be observed that contractors display a tall box plot. This suggests that the range of prices charged to farmers by this contractual arrangement is broad and that it can vary quite often, depending on the contractor. In contrast,

[8] The prices for mechanization services were originally reported in three units: INR per hour, INR per bigha, and INR per acre. The most common unit to measure land and to estimate a price for mechanization services in the study area are Bighas, which are equivalent to 0.1619 hectares. Therefore, in this section, INR per bigha are the unit used to measure the price paid for mechanization services.

for EM3 the range of prices displayed is shorter, which suggests that the price for this machinery is more stable. For seed drill, cultivator, and tractor the box plots do not show a considerable difference between the prices charged by the different contractual arrangements, although it can be seen that in the case of the contractors, outliers are clearly displayed. In the case of the sprayers, farmer groups, who provide the service in 25 percent of the transactions for this machinery, show a tall box plot, compared with the contractors. This suggests that the price charged by this provider varies quite often among the machinery owners who offer mechanization services under this contractual arrangement.

Table 14. One way ANOVA and Kruskal-Wallis H Test for prices of top 5 machinery

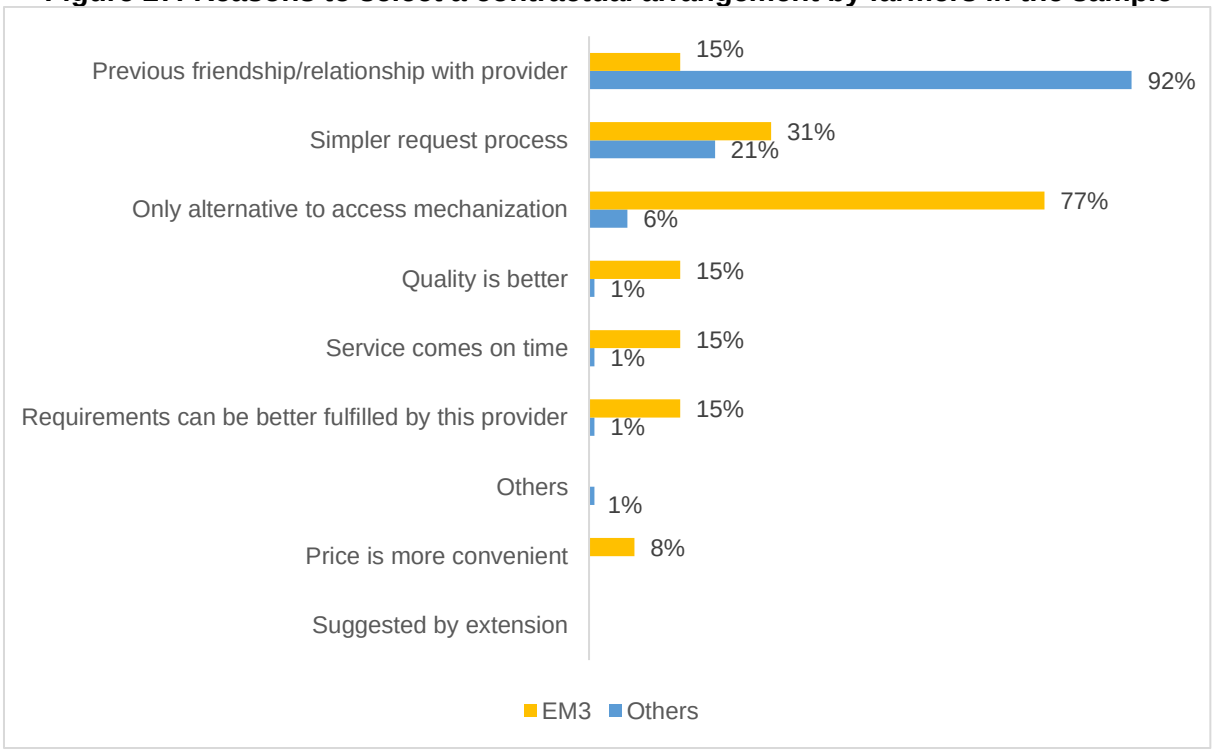
Machinery	Mean (INR per bigha)	SD	One way ANOVA Output	Kruskal-Wallis H Test
Combine harvester	447,65	59,85	F(2,31)= 0.54, *p*=0.5897	H=1.747, 2 d.f., *p*=0.4175
Seed drill	243,21	242,72	F(3,26)= 0.86, *p*=0.4728	H=4.727, 3 d.f., *p*=0.1929
Cultivator	199,43	174,97	F(3,20)= 0.36, *p*=0.7830	H=0.537, 3 d.f., *p*=0.9106
Sprayer	228,33	176,88	F(1,16)= 3,82, *p*=0.0684	H=2.655, 1 d.f., *p*=0.1033
Tractor	250,16	268,42	F(3,12)= 0.55, *p*=0.6601	H=3.006, 3 d.f., *p*=0.3907

Source: The Author

Nonetheless, in order to assess whether the prices charged by the contractual arrangements for the different types of machinery are significantly different, a set of statistical tests were conducted. In table 14, the means of the prices charged for each type of machinery are shown, together with the output of the one-way ANOVA and the Kruskal-Wallis H Test. First, the one-way ANOVA was carried on in order to compare whether there was a statistically significant difference in the means of the prices charged by the providers, for each type of machinery. The results of this test show that for the 5 types of machinery, the differences in the means of the prices charged by the providers are not statistically significant at the $p<.05$ level. This suggests that the prices paid by the farmers to the different contractual arrangements do not considerably diverge from each other. In the case of the sprayer, there is a statistically significant difference between the means of the prices only at the $p<.10$ level. In addition, taking into consideration that the prices charged by the providers are not normally distributed for the different types of machinery, a non-parametric test was conducted in order to confirm the output of one-way ANOVA. The Kruskall-Wallis H Test was selected for it allows determining if there are statistically significant differences between the means of the prices charged by the contractual arrangements when normality is not met. The results of this test also report that there is not a statistically significant difference in the prices that the farmers paid to the contractual arrangements at the $p<.05$ level.

Therefore, the differences in the prices charged by the contractual arrangements do not seem to be a consistent approach to understanding why farmers decide to hire mechanization services with a specific provider. In this context, the respondents in the sample were also asked about the main reason why they decided to hire a contractual arrangement in the last year. In Figure 27, the farmers' answers were classified into two groups: those who hired EM3, and those who hired any of the other contractual arrangements. Among EM3 users, 77 percent selected this contractual arrangement because it was their only alternative to access mechanization in the area. In addition, 31 percent considered that the request process for agricultural machinery was simpler with EM3. Other aspects, such as the quality, timeliness, price, and the technical requirements of the service show less importance for EM3 users. For the farmers who hired the other service providers, having a previous friendship or relationship with the provider was considered as the most important reason to choose an operator by 92 percent of the respondents. Moreover, 21 percent of these farmers considered that the contractual arrangement they chose offered them a simpler request process. The other aspects also show a limited influence on the farmers´ decisions in order to select the contractual arrangements.

Figure 27: Reasons to select a contractual arrangement by farmers in the sample



Source: The Author

5.3 Transaction costs analysis of mechanization services provision

The evaluation of the access to mechanization services in section 5.2 allowed to understand the preferences of the different categories of farmers regarding the contractual arrangements, types of machinery and prices. However, a full understanding of the costs of seeking information, coordinating, and enforcing contracts that the farmers in the area need to face in order to access to mechanization services cannot be addressed without the assessment of the transaction costs.

In this section, the analysis of TC has been divided into two subsections. The first one aims to estimate the most important TC related to the top 5 types of machinery hired in the sample. The second section incorporates the evaluation of the TC with the contractual arrangements which offer mechanization services in the area.

5.3.1 Assessment of TC for the most frequently contracted machinery in the area

In table 15, the importance of the four attributes related to the TC analysis for the most frequent machinery hired is estimated. First, it can be observed that combine harvester, seed drill, and cultivator show a higher asset specificity, which is due to their use for specific activities. In contrast, tractor shows a lower specificity given the multiple activities in which this machinery can be used.

Table 15. Assessment of transaction costs for the most hired types of machinery in the sample

	Attributes of transaction	Importance of the attributes by type of machinery				
		Combine harvester	Seed drill	Cultivator	Sprayer	Tractor
1	Asset specificity	+++	+++	+++	++	+
2	Uncertainty	++	+++	+++	++++	++
3	Frequency	++	+++	+++	++	++++
4	Group activities	+	++	+	++	+

Scale: "+" stands for 1. Not specific, 2.Certain, 3. Seldom hired, 4. No group activities required.
"++++" stands for 1. Very specific, 2. Uncertain, 3. Very often hired, 4. Group activities are very important.
"++" and "+++" stand for intermediate values between the higher and lower limits.
The scale was created by the author

Source: The Author

Then, uncertainty was analyzed by evaluating the number of days that farmers spent finding a provider, the number of days they waited for the mechanization service once they have requested it, and by assessing whether the machinery was available when they needed it. The results suggest that the transactions related to the hiring of combine harvesters and tractors have the least uncertainty. In fact, the time to find the operator and to wait for the machinery together reached an average of 2,28 days for the combine harvesters and 2,79 days for the tractors. Moreover, in both cases, farmers reported that the rate of availability of the machinery

was circa 60 percent. The hiring of seed drill and cultivator displayed intermediate uncertainty, with a waiting time of 2,89 days and 2,57 days and an availability rate of approximately 50 percent. The highest uncertainty corresponds to the hiring of sprayers, with an average waiting time of 3,08 days and an availability rate of 34 percent.

Moreover, tractors, cultivators, and seed drills showed a high frequency[9] of hiring by the farmers, with an average of 3,11; 2,92; and 2,75 times per year, respectively. In contrast, combine harvesters and sprayers were hired 2,05 and 1,89 times during the same year. Group activities, which in the study refer to the need of the farmers to get together to add up an area of land, are more important for seed drill and sprayer. Indeed, on average, in 24 percent of the transactions related to the hiring of the sprayer and in 21 percent of the transactions related to the hiring of the seed drill, group activities were required by the providers.

The assessment of the different attributes for the most hired types of machinery suggests that the cultivator, sprayer, and seed drill display the highest transaction costs for the farmers. In fact, they show a high uncertainty and asset specificity, combined with an intermediate hiring frequency. This suggests that there is a high demand for these machinery several times per year, however, in many cases, farmers are not able to access the machinery when they need it. In addition, it can be established that when the machinery is more frequently used, more farmers prefer to own the technology, which can be confirmed in Figure 23. In fact, tractor, cultivator, and seed drill report the highest rate of ownership and the highest frequency. Moreover, it can be considered that farmers prefer to own assets which are less specific, thus, tractors show the highest rate of ownership.

5.3.2 Evaluation of TC for the most frequently contracted machinery in the area under the different contractual arrangements

For the second stage of the analysis, Table 16 incorporates the attributes of the types of machinery with the contractual arrangements. The overall TC score of the contractual arrangements is analyzed by the assessment of the attributes for each type of machinery. In general, it can be observed that the results of asset specificity show a neutral effect when related solely to the contractual arrangements. In fact, as displayed in Table 15, the specificity of the machinery is usually aligned with its technical features, rather than with which contractual arrangement offers the service. For the other attributes, the TC analysis does not show a general trend and, therefore, the assessment is conducted for each one of the contractual arrangements.

[9] In comparison with table 13, which classifies the machinery according to the share of farmers who have hired it during the last year, table 15 evaluates frequency by measuring the number of times that the machinery was hired by the same household during the last year.

Table 16. Importance of transaction costs as factors explaining the choice for contractual arrangements

Attributes of transaction	Providers of machinery services and the importance of attributes of TC			
	Contractors	**EM3**	**Farmer groups**	**Informal sharing**
Combine harvester				
Asset specificity	0	0	0	0
Uncertainty	-	++	-	++
Frequency	++	-	++	-
Group activities	-	--	+++	+++
Seed drill				
Asset specificity	0	0	0	0
Uncertainty	-	++	--	+++
Frequency	++	-	-	+++
Group activities	--	+++	--	+++
Cultivator				
Asset specificity	0	0	0	0
Uncertainty	--	+	--	+++
Frequency	++	--	-	+++
Group activities	--	+++	+++	+++
Sprayer				
Asset specificity	0	0	0	0
Uncertainty	+	0	--	+++
Frequency	+++	0	+	-
Group activities	--	0	+++	+++
Tractor				
Asset specificity	+	++	+	+
Uncertainty	-	++	+	+++
Frequency	+++	-	--	+++
Group activities	--	+++	+++	+++

Scale: "+" indicate that the attribute encourages the choice of this contractual arrangement ("+" encourages little, "++" moderately encourages, "+++" encourages a lot).
0 indicates a neutral effect of the attribute on the contractual arrangement.
"-" indicate that the attribute discourages the choice of this contractual arrangement ("-" discourages a little, "--" moderately discourages, "---" discourages a lot).
Source: The Author

Contractors display a high and sustained level of frequency for the different types of machinery. In fact, for the hiring of combine harvesters, tractors, and sprayers they show the highest level of frequency among the contractual arrangements. This attribute is crucial since it reflects a repetition of interactions between the private contractors and the farmers, which could play a determinant role in mitigating the costs associated with the transactions. Nonetheless, the hiring of contractors also seems to be related to high uncertainty and group activities. Overall, the time spent by the farmers looking for the provider and waiting for the service is the highest when they hire the contractors. For example, in the case of the seed drill, farmers reported that they had to wait on average 3,19 days when they hired contractors, whereas for EM3 the waiting time was 2,5 days, for farmer groups 2,27 days, and for informal sharing 2 days. In addition, the availability rate of the machinery, which directly influences uncertainty, was also

lower for contractors. In fact, in the case of the seed drill, the machinery was available 46 percent of the times during the last year with the contractors, while with farmer groups was 23 percent, and for EM3 and informal sharing was 100 percent. This can suggest that the low level of availability of the machinery offered by the contractors encourages the farmers to look for new contractual arrangements. Furthermore, Table 16 reflects that group activities are more often required by contractors than by other providers. On average, contractors required group activities in 25 percent of the transactions, while EM3 required them in 5 percent, farmer groups in 6 percent, and informal sharing never required them.

Table 16 suggests that the business model developed by EM3 allows reducing uncertainty and group activities. EM3 displays the second lowest uncertainty among the contractual arrangements in the area, which is mainly due to a high availability rate and shorter waiting time. Farmers reported that in the last year, the machinery offered by EM3 was always available when they needed it. For instance, for the hiring of tractors, farmers reported an availability rate of 100 percent and a waiting time of 2,5 days on average, compared with a waiting time of 3,1 days with the contractors, 3 days with the farmer groups and 2 days with the informal sharing. In addition, group activities show a low prevalence among the farmers who hired the services in EM3. This potentially signifies less time in agreeing with other neighboring farmers to add up an area of land that would be attractive to the mechanization provider. Only in the case of combine harvesters, 25 percent of the farmers reported that EM3 operators required them to perform group activities, whereas for the hiring of all the remaining machinery group activities were reported as not required. Nevertheless, the analysis of TC shows that there is still a low frequency of transactions between the farmers and EM3. In fact, overall, EM3 displays the lowest frequency among the contractual arrangements, which is 30 percent lower than the average. This could increase the TC related to the generation of trust by the farmers and the operators. The limited frequency could be partially attributed to the developing stage of the company, which is new in some areas and is aiming to start building up a connection with the users.

In the case of the farmer groups, the main strength seems to arise from the low requirement for group activities. The assessment of the TC shows that farmer groups only require group activities for the provision of seed drill services. For all the other types of machinery, group activities are not required. However, the attribute which currently limits the development of this contractual arrangement is uncertainty. This is particularly evident in the case of the seed drills and cultivators, in which the limited availability rate increases the uncertainty of the transactions. Indeed, under this contractual arrangement, seed drills are only available 23 percent of the times, and cultivators 46 percent of the times, compared with a 100 percent availability of EM3 and informal sharing. Additionally, frequency does not show a consistent effect on the different types of machinery. While for combine harvesters, sprayers, and tractors,

the frequency of the transactions seems to encourage the use of farmer groups, for the hiring of seed drills and cultivators the frequency seems to be discouraging for the hiring of this contractual arrangement.

In a similar way to EM3, informal sharing displays very good performance in reducing uncertainty and group activities. In fact, from the contractual arrangements analyzed, informal sharing shows the less TC related to uncertainty. This is due to a high availability rate since farmers reported that with informal sharing the equipment was always available when they needed it. Moreover, this contractual arrangement shows the shortest waiting period for all the types of machinery considered for the TC analysis. In fact, the waiting time of informal sharing was reported as 27 percent lower than the average of all the contractual arrangements. Furthermore, frequency shows an ambiguous result for the different types of machinery. On the one hand, it reduces TC when it refers to seed drill, cultivator, and tractor. However, for combine harvesters and sprayers, the low frequency between the providers and the farmers seemed to increase the TC.

In this point, it is crucial to mention that the assessment of TC for EM3 Agri Services does not incorporate the use of mobile tools into the hiring of mechanization services. In fact, as already mentioned in section 5.1, the app that is supposed to match the farmers with the providers was still not being used by the time the fieldwork for this research took place. As a result, the TC impact of mobile-based-platforms in comparison to the other contractual arrangements could not be assessed.

5.4 Evaluation of the organizational and governance challenges faced by the business model

The assessment of the governance challenges faced by the business model implemented by EM3 is summarized in Table 17. The analysis focuses on the market failures and state failures, which are the two institutional structures involved in the provision of mechanization services in the model. In order to provide quantitative evidence of the main challenges encountered, the percentage of respondents who mentioned the challenge during the interviews and the NPM sessions is displayed.

Figure 28. Net Process Mapping sessions in Kota and Bundi districts in Rajasthan

Source: The Author

As already mentioned in section 5.1, the business model implemented by EM3 is in an early stage and an app that connects the requests of the farmers with the local suppliers is still not available. Nevertheless, the development and set-up of the franchisees' CHC and the potential of this model can already be analyzed through the Institutional Economics framework in order to identify current and future governance challenges.

Table 17. Frequency of challenges as mentioned by respondents

Governance structures	Type of challenge	Interviews (15)	NPM (2)
		% of respondents who mentioned theme	% of NPM sessions during which the theme was mentioned
Market failure	**Merit goods**		
	Limited skills of operators	13%	0%
	Information asymmetry		
	Unclear commission payment process	13%	50%
	Land measurement	27%	0%
	Principal-agent problem		
	Fulfillment of minimum hours of service provision	7%	50%
	Quality of on-farm service provision	33%	50%
State failure	**Lack of financial sustainability**		
	Reliance of the model on the subsidy	53%	50%
	Information problems		
	Impact on small-scale farmers and low mechanized areas	7%	50%

*The interviews with the franchise owners and operators were used to evaluate the challenges of the business model.

Source: The Author

5.4.1 Limited skills of operators

As described in section 2.3.3, one of the main challenges that mechanization faces in India is the lack of training among the machinery operators. The implementation of SMAM includes as one of its core pillars, the provision of training as a key strategy for improving the impact of mechanization. However, all the operators interviewed claimed that they did not receive any type of training by EM3. This can be attributed partially to the fact that the operators interviewed have worked with EM3 for a short period of time, which in most of the cases was between 3 to 5 months. The information presented in Table 17 suggests that 13 percent of the providers interviewed considered the limitation of their skills to operate machinery as a challenge. Nonetheless, all of them also claimed to have the expectation that working with EM3 would improve their abilities.

5.4.2 Unclear commission payment

In the guidelines of the agreement between EM3 and GOR, it is mentioned that it is essential for the CHCs to have at least one implement available for each one of the five stages of the crop cycle (land preparation, sowing, crop care, harvesting, and postharvest). EM3 has done an exhaustive identification of the candidates in order to guarantee that the farmers who use their service can have access to all the types of machinery they need. In this point, it is important to mention that most of the franchises were already providing mechanization services and had own machinery before they joined EM3. Indeed, 80 percent of the franchisees interviewed claimed that they were working as private contractors before working with EM3. Most of them owned implements such as tractors, cultivators and even combine harvesters. However, the way in which the payment of a 5 percent commission over the total revenue generated by the franchise should work remains ambiguous when it refers to machinery previously owned by the providers. Indeed, the operators are aware that they should pay a commission to EM3 for participating in the subsidy scheme. Nevertheless, the way in which the payment works is unclear for the machinery they previously owned and that is used for providing services in the franchise. According to Table 17, 13 percent of the operators mentioned that the information regarding this matter remains fuzzy. Moreover, one of the two NPM sessions also identified that the information about the commission payment was ambiguous in the case of own machinery. One of the franchises' owner mentioned: "It is the company's name that appears, but it's us who do all the work".

5.4.3 Land measurement

The most common unit to charge a price for the provision of mechanization services in the area is INR per bigha (equivalent to 0.1619 hectares). However, in many cases, the farmers are unsure of the size of the plots of land they own. Therefore, estimating the right price for the

service usually becomes a complex duty for contractors and farmers. EM3 has introduced land measurement as a mechanism to improve the payment of the service provision. Usually, either the field staff of the company or the franchisees measure the land of the farmers using the GPS of their mobile phones. This allows having a more accurate estimation about the size of the land they will work in and helps them to estimate the price. According, to the operators interviewed, this has been one of the most important innovations done by EM3 so far. In fact, one of them mentioned: "Before I worked with EM3, I didn't know the land size of farmers I was working for. Establishing a price was complicated and many farmers used to lie or also didn't know how big their plots were". Nonetheless, land measurement is still not a common practice in the area. Although some of EM3's users had their land measured, this remains a difficulty for most of the farmers and service providers in the area. Indeed, according to the data collected, 27 percent of the franchises interviewed considered land measurement to be still a challenge for them.

5.4.4 Fulfilment of minimum hours of service provision

In the contract that EM3 subscribes with the franchises, it is established that a minimum of 650 hours per year should be provided by the machinery subsidized, for 7 years. In case the minimum workload is not fulfilled by 50 percent of the machinery, the CHC is considered as non-performing and a percentage of the security deposit is taken as a sanction. However, this guideline is the source of several complications for the franchises. First, although subsidized machinery is supposed to have GPS devices installed to track its proper use, none of the pieces of equipment owned by the operators interviewed had one installed. In this context, without the tracking of a GPS, the workload goal could become an incentive to simply cover as much as land as possible, without any technical criteria. In fact, there is not yet a trustworthy mechanism to prove that the subsidized machinery is being used in the right way. This issue was mentioned by 7 percent of the people interviewed, as well as in one of the NPM sessions. In addition, for some of the operators, having a binding contract for 7 years limits their own capacity to develop the business. They consider that with the number of clients they have, they could have earned enough to pay back the subsidy in 4 years. In contrast, other operators are not entirely sure to meet the minimum number of hours and are actually concerned that if they underperform, they will need to pay back the security deposit with interests.

5.4.5 Quality of on-farm service provision

The provision of mechanization services with EM3 could face a typical case of the principal-agent problem. Even though EM3 aims to generate a standardized quality of its agricultural services by developing the franchise model, according to the franchisees interviewed, 33 percent of them usually hire external operators for the service provision. This could represent a challenge for EM3 since the operators could act in their own interests, which could differ from

the company's objectives. For instance, similarly to what is suggested by Daum & Birner (2017) for the case of Ghana, operators hired by the franchisees could have higher motivations to plow as much land as possible in a given time, which could be detrimental for the maintenance of the machinery and the quality of the service. Although franchises are currently obliged to ensure that the operator of the subsidized machinery has a valid drivers license, this requirement does not guarantee that the operator will provide good quality service.

5.4.6 Reliance on the subsidy

EM3's business model has attracted much attention in the agricultural arena for representing an innovative idea developed by a private company which aims to improve access to mechanization services by small farmers. Nevertheless, the analysis suggests that the influence of the government, through the subsidy offered by the GOR, is the backbone of the business model in the study area. In this sense, although the subsidy is key to increasing the farm power availability, it also plays a disruptive role in the market by incentivizing contractors to acquire more machinery at a convenient price. Indeed, 33 percent of the interviewees acknowledged that their strongest motivation to work with EM3 was to be able to access the subsidy. Moreover, the franchisees considered that the development of the business model without the subsidy could be a major challenge. As displayed in Table 17, the sustainability of the model without the subsidy was mentioned as a challenge in 53 percent of the interviews and in one out of the two NPM. This raises the question of whether the model could work in different scenarios. For instance, changes in the agenda of the politicians, readjustment of the subsidy, or even once the subsidy is over. Therefore, the assessment of the true impact and scope of the model remain ambiguous because of the strong influence of the subsidy offered by the government.

5.4.7. Impact on small-scale farmers and low mechanized areas

As suggested by Daum & Birner (2017), state failure can take place because of information problems which occur when governments fail to connect the demand and supply in the market. In the case of Rajasthan, SMAM aims to improve the scope and the quality of the mechanization services by allowing private companies to offer a market solution. In this context, one of the pillars of the agreement between the GOR and EM3 is to increase the reach of agricultural mechanization to small and marginal farmers and in regions of low availability of farm power. Nonetheless, the evaluation of the business model displayed in section 5.2, shows that the impact on marginal and small-scale farmers is still limited. In the study area, only 5 percent of the marginal farmers and 1 percent of the small farmers access mechanization services through EM3, whereas 17 percent of the large farmers use this contractual arrangement. Furthermore, in 7 percent of the interviews and 50 percent of the NPM sessions, the model's impact on small-scale farmers was considered as a challenge. In

addition, the study area could be considered as a region with intermediate to high availability of machinery, considering that 76 percent of the households own machinery and 75 percent usually hire mechanization services, compared with a national average of 45 percent. Therefore, although the study sample only represents one of the areas in which the company is currently operating, it is crucial to determine whether the pre-evaluation conducted by EM3 in order to identify the main areas for the establishment of CHCs is the most accurate mechanism to improve the access to mechanization for marginal and small farmers and for low-mechanized areas.

6. DISCUSSION

6.1 EM3 in the Sharing Economy and the "Uberization" of agriculture

The model implemented by EM3 Agri Services has been referred in India as "the Uber for farm machinery" due to the development of a mobile platform which allows placing orders for renting farm equipment between providers and users. Nonetheless, the similarities and the differences between EM3 and the model developed by Uber have not been assessed by the previous literature. In this sense, the "uberization" should be understood as part of the Sharing Economy, which is a larger and global concept used to comprehend the way in which the traditional conception of supply and demand is being changed by platforms that use mobile communications and technological advances. According to Sundararajan (2016), the Sharing Economy encompasses different types of platforms in which some business develop markets that promote entrepreneurship, while others resemble more to hierarchies that employ contractors. This author suggests that Uber fits mostly into the second type of platforms, which is characterized by the crucial role of the platform in assigning providers to the customers, and providing centralized customer support. From this perspective, the model implemented by EM3 could be considered to present similarities with the one developed by Uber. Nevertheless, EM3's lack of a digital platform that connects farmers with providers and its pay-per-use approach for the business are two key factors that hinder the understanding of the model developed by EM3 as part of the SE.

Technological infrastructures which allow online accessibility for the exchange of services are a distinctive feature of SE models. In fact, the literature suggests that they are critical for allowing direct and immediate exchange of services between users and providers. However, despite the innovation shown by the business model developed by EM3, the absence of a digital platform limits the evaluation of EM3 as part of the SE. In this context, Bauwens (2006) for example denotes that for P2P processes to operate, an infrastructure needs to be created in which the existence of a technological set-up is determinant. Through this infrastructure, peers can have distributed access to capital and generate autonomous communication. Additionally, a platform is crucial in developing a sharing community in which trust-based relationships enable to exchange services based on a reputation (Sundararajan, 2016). In this sense, it can be stated that as long as a mobile platform is not incorporated in the business model, this initiative cannot be considered as one of the models that belong to the SE.

Moreover, it is crucial to mention that EM3 bases its model on a pay-per-use approach, in which customers do not need to buy the product, but rather just pay for its usage, whereas the asset ownership remains with the provider (Gebauer, Saul, Haldimann, & Gustafsson, 2017; Tukker, 2004). Due to its pay-per-use approach, the model does not use peer to peer (P2P)

activity and crowd-based networks, as suggested by SE models. Indeed, as argued by Bauwens (2006), P2P represents a 'third mode of governance', characterized by the free cooperation of producers who do not rely on the intermediation of corporate hierarchy and aim to distribute knowledge equitably among users in order to reduce information asymmetry. In contrast, EM3 rather bases its work on the operation of franchises which provide farm services based on the coordination of a central corporation. Hence, free cooperation among the providers, which is a pillar of the P2P model, is not present in EM3's model. The model relies on a clear and central institution, rather than on a decentralized group of providers which operate with own capital and labor. Thus, the model cannot be said to follow the crowd-based pattern indicated by the literature.

The literature review suggested that models which belong to the Sharing Economy display a group of core characteristics. In this sense, probably one of the most novel features of SE models is related to turning an asset's idling capacity into revenue by matching those who have idling capacity with those who need the asset, suggesting a reduced need for ownership. In this point, on the one hand, the business model developed by EM3 and GOR aims at reducing the need of the farmers to buy agricultural machinery that they could rather hire. Nonetheless, as suggested by (Towson, 2017a), the application of the subsidy on new machinery plays a disruptive role in the model by fostering the ownership of more pieces of equipment by the franchisees. Indeed, although farmers do not need to buy the machinery, the owners of the CHCs across the state are adding up the number of machinery in order to provide the service. Therefore, it can be argued that from the demand side, the model reduces the need of ownership by the farmers, however, from the supply side it enhances the ownership of more new and advanced machinery which does not relate to the reduction of the idle time displayed in other SE platforms.

6.2 Access to mechanization services in the study area and the role of EM3

The "uberization" of mechanization services has captured attention in the agricultural arena for its potential of improving and increasing the access to agricultural machinery for smallholder farmers by adopting new mobile technologies. The two most important innovations commonly attributed to this approach refer to allowing access to mechanization services for farmers who are not able to buy agricultural machinery and helping machinery owners increase their revenue by renting their equipment to those farmers. In this sense, it is expected that the "uberization" would promote a more affordable and effective provision of machinery services, based on the use of mobile tools.

As previously mentioned, it is still difficult to assess the impact of digital platforms in the provision of mechanization services due to the absence of such a tool in EM3's operation.

Nonetheless, the data collected allows evaluating the role of EM3's franchises on the provision of mechanization services for small farmers. In this context, first, it is important to recall that one of the core objectives of the Submission on Agricultural Mechanization is to increase the marginal and small farmers' access to mechanization in regions of low farm power availability. The evaluation of the study area indicates that 35 percent of the farmers operate landholdings of less than 2 ha. From this group, 89 percent hire machinery services on a common basis mainly through private contractors and farmer groups. In fact, these two contractual arrangements were hired by 86 percent of the marginal and small farmers during the last year. However, this group of farmers has hired EM3 only in 4 percent of the transactions. In contrast, the data reveals that 17 percent of the large farmers and 9 percent of the semi medium farmers have hired EM3 in the last year. Therefore, so far, the model does not reveal a direct impact on increasing the marginal and small farmers' access to mechanization services since there is no evidence of prioritization of this group of farmers by the business model and the franchises.

Moreover, the analysis of the most demanded machinery by contractual arrangement in the study area suggest that so far there are no significant differences in the prices charged by EM3 and the other providers. In fact, when assessing the prices for the hiring of the combine harvester, seed drill, cultivator, sprayer, and tractor, the one-way ANOVA output and Kruskal-Wallis H Test showed that there is not a statistically significant difference in the prices at the $p<.05$ level. Although one of the intuitions of the model implemented by EM3 and GOR is that operators who acquired subsidized machinery would offer services at a lower price, there is no evidence that this is influencing the actual price. Hence, based on this case study, the premise that "uberization" could promote a more affordable provision of mechanization services fails to be demonstrated.

The study also allows assessing the most relevant criteria that farmers apply to select a provider of mechanization services. The data shows that 77 percent of EM3's users selected a franchise because it was their only alternative to access to mechanization services in the area. This suggests that some of the franchises are operating in areas which traditionally had limited access to mechanization. Nonetheless, this does not guarantee necessarily that smallholder farmers are increasing their access to machinery in these areas. Furthermore, it is essential to mention that a previous friendship or relationship with the service provider was considered by 92 percent of the farmers who hired other contractual arrangements as the most important criterion to select a provider. This could limit the potential of SE models in the rural areas as they mainly consider the proximity, rating, reputation, or ability to provide the service as factors from which users can choose a provider. However, in the case of agricultural machinery services, addressing the importance of previous linkages between users and

providers seems to be a determinant factor which could have a pivotal role in the potential of the “uberization” models.

In addition, one of the crucial points to assess the potential impact of digital-platform-based mechanization services is the current access and use of ICT by the farmers. In this sense, the study shows that access to the internet and the use of smartphones in the study area remains limited, especially among smallholder farmers. While at the national level, it was estimated by IAMAI that only 20 percent of the rural population had access to the internet by the end of 2017 (The Economic Times, 2018), the data collected in the study area suggests that in the last year, 56 percent of the households owned or had access to a smartphone. Nonetheless, the rate of access to smartphones for small landholdings in the study area shows that only 23 percent of the marginal farmers and 27 percent of the small farmers have a smartphone.

Furthermore, the results show that in order to increase the potential impact of digital platforms in agriculture, it is essential to develop the farmers’ knowledge and awareness about the benefits of smartphones and the way they operate. In fact, the results of the study show that the two main reasons why farmers decide not to have a smartphone are that they consider this technology as not useful for them in 63 percent of the cases and that they lack the knowledge required to handle a smartphone in 34 percent of the cases. Moreover, it is noteworthy that among the farmers who took part in the study, the use of mobile phones is limited to the most basic aspects. According to the data, 99 percent of the respondents mainly use their mobile phone to call, while 36 percent to take pictures and only 24 percent to access social media.

6.3 TC analysis for the providers of mechanization services

The assessment of the most frequently hired machinery among the contractual arrangements shows that, so far, the model developed by EM3 allows reducing TC arising from uncertainty and group activities. The study shows that EM3 displays the second lowest uncertainty in transactions among the contractual arrangements in the area, which is a result of the higher availability rates of the machinery and shorter times in finding the provider as well as in waiting for the service. This suggests that farmers who hired EM3’s services in the last year had a timelier service provision than those who hired contractors and farmer groups. Moreover, the analysis shows that transaction costs arising from group activities are lower among EM3’s franchisees. This indicates that farmers who hired EM3’s franchisees did not require to spend time in agreeing with other neighboring farmers to add up an area of land that would be attractive to the mechanization provider. However, when compared with the other contractual arrangements, EM3’s users seem to face higher TC arising from a lower frequency. Although many customers and EM3’s franchisees knew each other from before, there is a lower frequency of the new users of the service. This can be attributed to the developing stage of the

company and its franchisees, especially considering that the CHCs started operating in March 2018. Nevertheless, taking into the consideration the importance attributed by the farmers to a previous relationship with the provider when selecting a contractual arrangement, the importance of reducing TC arising from frequency is a factor which should not be neglected by EM3.

It is also noteworthy that all in all, the informal sharing displays the lowest TC from all the contractual arrangements available in the area, especially related to uncertainty and group activities. Private contractors and farmer groups are the most important providers of machinery services in the area, accounting together for approximately 80 percent of the transactions in the last year. Nevertheless, in both cases, hiring these contractual arrangements involves higher TC related to uncertainty and group activities for the farmers. In this regard, despite being the least used contractual arrangement, the analysis suggests that informal sharing offers the least TC for the farmers. On the one hand, this finding offers a valuable insight since according to the characteristics presented by the informal sharing and the model implemented by EM3, it can be established that informal sharing displays more similarities with the features of the SE models. In fact, although a digital platform is not used by this contractual arrangement, it complies with the reduction of the assets' idling capacity, it is based on an informal peer to peer activity, and it does not rely on the role of a centralized institution. Nonetheless, this finding reflects only a partial understanding of the features of the provision of mechanization services in the area and need to be analyzed carefully. Indeed, it is important to mention that not all the types of TC that farmers face to hire mechanization services could be estimated. Attributes such as complexity, measurability, or investment level, which were assessed by other studies (Wander et al., 2003), could not be estimated for EM3' case study. In addition, as shown in Table 13, informal sharing is mainly relevant for the hiring of basic machinery such as tractors and cultivators. However, for machinery with a higher price and higher asset specificity, the hiring of contractors and farmer groups has a predominance.

6.4 Limitations and further research needs

The assessment of the case study of EM3 Agri Services offers valuable insights about the potential of innovative business models for agricultural mechanization. Nonetheless, the role of the digital platforms in promoting the farmers' access to mechanization services could be assessed only partially due to the absence of a smartphone app that matches farmers with the franchisees. Therefore, there is a need to further analyze the impact of these models over time and in different areas. In fact, several machinery manufacturers and startups have undertaken similar business as the one developed by EM3 in different regions. Evaluating their experiences in implementing digital tools to increase the farmers' access to mechanization and

reducing transaction costs could offer relevant information in order to estimate the potential of these tools in improving the smallholder farmers' access to mechanization.

In addition, the findings show that in spite of the revolutionary role attributed to the "uberization" models for mechanization services, the case study of EM3 suggests that there is a need to assess the farmers' trust in digital platforms. In fact, the results show that farmers' most relevant reason to select a contractual arrangement is related to the importance of a previous relationship with the provider. This suggests that face-to-face relations still play a relevant role for farmers when choosing an operator. In this sense, understanding the main drivers of this trust and the way in which digital platforms can address this issue could offer critical tools to further develop these models.

The study aims to provide a general framework to rank the importance of TC for "uberization" models and conventional providers. Though, the recent application of the model allowed estimating only the most relevant TC, such as asset specificity, uncertainty, frequency, and group activities. In this regard, it is crucial to further measure the effect of other relevant TC on the provision of mechanization services under "uberization" models, as suggested by the literature. The assessment of attributes such as complexity of the contracts, measurability, special hold-up, and investment level over time could provide a more detailed analysis of the potential of these models to reduce transaction costs, especially for smallholder farmers.

Furthermore, the analysis shows that transaction costs arising from uncertainty and group activities have been reduced by EM3. However, the ranking also reveals that the transaction costs are even lower for farmers who used informal sharing as a contractual arrangement. Hence, it is crucial to analyze the current dynamics of informal sharing in order to understand if this structure represents a more accurate representation of the SE features and if a potential digitalization of this structure could improve the farmers' access to basic machinery.

Finally, this case study captures the experiences of EM3's franchisees and users through a small sample of the first districts in which this model was implemented. Hence, it would be important to develop similar studies with larger samples once more CHCs start operating. This will allow to select more randomized samples and draw more general conclusions about the potential of the business model implemented by EM3.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The literature review reveals that in order to understand the most important characteristics of the “uberization” models in agricultural mechanization, it is essential to understand first the features of the Sharing Economy. In this regard, even though there is not yet an agreement on the definition and the determinants of SE models, different authors agree on the relevance of a group of factors. The most relevant features which seem to be crucial for the understanding of SE models are: i) the use of the capital at its full capacity, which reduces the idle time; ii) the direct peer to peer activity, allowed by the emergence of new technological platforms; and iii) the interaction between supply and demand based on crowd-based networks, which replace big corporations or centralized institutions. In this way, the main potential benefits attributed to the “uberization” models in agricultural mechanization are related to 5 main aspects: i) improvement of timeliness, ii) reduced need for ownership, iii) decrease of machinery’s idling capacity, iv) increase of transparency and inclusiveness, and v) access to high-tech and specific machinery.

Inspired by the model of Uber, EM3 has emerged as a company that introduces a group of innovations in the provision of mechanization services in Rajasthan. The franchise-based and pay-per-use model has allowed to set up a more formal provision of machinery services in the region. Many former private contractors, input distributors, and local entrepreneurs who currently operate franchises across the state consider that working with EM3 gives them the opportunity to manage their own business and to improve their livelihoods. Moreover, the subsidy provides the franchisees with the funding required to afford necessary machinery and even high technology equipment, such as laser land leveler or combine harvesters. This allows them to offer more varied and specific services. In addition, land measurement is considerably facilitating the pricing for mechanization services in the area. This leads to a better estimation of the time required for the service provision and to an improvement of the understanding between the farmers and the operators. Finally, the aggregation of franchisees is a revolutionary approach, which allows the company to offer a wider range of services to farmers of a specific area.

However, it is notable to mention that in spite of the innovative model implemented by EM3, the potential impact of the digital platforms in improving access to mechanization services is still to be proved. Although much attention has been given to EM3’s business model by the media because of its mobile-tool-based nature, the digital platform that is supposed to match the farmers with the mechanization providers is still not operating. In this sense, the farmers’ ability to request mechanization services through a smartphone is still not a reality. Hence, the

results of the research can only offer hints to analyze the impact of such models in mechanization services but do not allow to evaluate the full potential of the digital platforms in improving the access to those services. In addition, the subsidy for new machinery provided to the franchisees limits the evaluation of the prospects of the model. Although the government's support for the financing of new machinery plays a crucial role in increasing the farm power availability in the study areas, it also plays a disruptive role for the dynamics of the "uberization" of mechanization services. Indeed, from a theoretical perspective, the subsidy distorts the market of mechanization which hinders the potential to evaluate the true motivations and challenges which the stakeholders would face to implement digital platforms in the provision of mechanization services.

The comparison of EM3 and the other contractual arrangements available in the area allows evaluating the performance of the business model based on a survey of 101 households which used mechanization services in Bundi and Kota in the last year. In this context, the analysis shows that, overall, 76 percent of the households surveyed own at least one piece of machinery. There is a statistically significant association between the size of the landholdings and the ownership of machinery. Indeed, it was estimated that while only 38 percent of the marginal farmers owned a piece of machinery, all the large farmers had their own machinery. Tractor, cultivator, and seed drill are the types of machinery most commonly owned by the farmers, while combine harvester, reaper, and laser land leveler are rare. The findings also show that in spite of the high ownership rate, still, 75 percent of the farmers hired mechanization services in the last year. The findings reveal that there are four main types of contractual arrangements in the study area. Contractors, who were hired in 28 percent of the transactions, farmer groups, with a share of 9 percent, EM3 with 5 percent, and informal sharing with 3 percent.

Moreover, in contrast with the premise that "uberization" would create more affordable mechanization services for farmers, the results reveal there are no significant differences in the prices charged by the contractual arrangements. According to the study, combine harvester, seed drill, cultivator, sprayer, and tractor are the machinery most commonly hired by the farmers. For this machinery, the One-way ANOVA and Kruskal-Wallis H Tests show that there are not statistically significant differences in the prices charged by the four contractual arrangements for agricultural mechanization services. The findings suggest that considering that there are no significant differences in the prices, most of the farmers usually base their selection of contractual arrangements on the existence of previous friendships or relationships with the providers. In fact, the data indicates that for 92 percent of the farmers who hired other contractual arrangements this is the most crucial aspect considered to hire a provider.

In addition, the findings show that the model's impact on small and marginal farmers is still limited. So far these groups of farmers represent only 23 percent of EM3's customers. In fact, 77 percent of the users are farmers who own 2 ha or more, who in the case of India are considered as medium to large farmers.

The study also reveals that in order for "uberization" models to operate, there is a crucial need to promote farmers' digital empowerment. One of the crucial findings is that while overall 56 percent of the households currently use a smartphone, only 23 percent of the marginal farmers and 27 percent of the small farmers currently use one. In this regard, the farmers' knowledge and awareness about the benefits of digital tools, such as smartphones, seems to be limited. Farmers report a lack of interest in the use of these devices, which can be reflected by the fact that 63 percent of them consider them useless and 34 percent do not know how to use them. In addition, the assessment of the mechanisms currently used to hire mechanization services in the area reveals that 83 percent of the farmers hire a provider through a phone call and 17 percent still do it through informal talks. Internet-based tools or SMS messages are not currently used for this matter.

The research analyzes the attributes of transaction costs arising from asset specificity, uncertainty, frequency, and group activities. In this sense, the findings show that farmers in the study area face high transactions costs due to the asset specificity for hiring combine harvester, seed drill, and cultivator. Moreover, the TC ranking shows that farmers who hired EM3 were able to reduce TC arising from uncertainty and group activities. Indeed, compared with the other contractual arrangements, EM3 allows reducing the time spent on finding a provider and waiting for the service, especially for combine harvester, seed drill, and tractor. In addition, the franchises display an overall 80 percent availability rate when requested, compared with a 50 percent by the contractors and 40 percent by the farmer groups. Furthermore, EM3's franchisees required group activities in 6 percent of the transactions, compared with 22 percent by the contractors and 7 percent by the farmer groups. However, it is also noteworthy that EM3's users face the highest TC related to frequency. In fact, due to the developing stage of the company, the assessment reports that farmers hire EM3 with a 30 percent less frequency than the other providers.

Therefore, the case study of EM3 Agri Services in Rajasthan offers insights into the implementation of Uber-like models for agricultural mechanization. The literature review and the description of EM3 franchises' indicate that although EM3's model is inspired by Uber, there are considerable differences between the two approaches. The absence of a smartphone app to connect farmers with tractor providers and the subsidy for new machinery offered to the CHCs display a different business pattern which limits the understanding of this model as part of the Sharing Economy and as an Uber for agriculture. Moreover, the analysis of the local

market of mechanization services shows that private contractors and farmer groups are still the main providers of mechanization, whereas the reach of EM3's franchises is still limited. The results also reveal that so far EM3's franchises are mainly hired by medium and large farmers, whereas small and marginal farmers usually hire contractors. Additionally, the TC analysis between EM3 and the other contractual arrangements shows that farmers who hired EM3 in the last year report fewer transaction costs arising from uncertainty and group activities. Nonetheless, in most of the cases, they also face higher transaction costs due to a lower frequency.

In this regard, the model developed by EM3 offers a new approach for providing mechanization services in Rajasthan, however, it still does not show significant differences when compared with the conventional models. Based on the case study, it can be established that the "uberization" models could have the potential to solve some of the farmers' issues in order to access machinery but they strongly depend on the farmers' ability to access and use of ICT. Indeed, the limited adoption of ICT technologies by smallholder farmers shows that there is a digital gap between the developers of such models and their potential users. Without farmers' digital empowerment the potential of "uberization" models in agriculture will remain limited.

7.2 Recommendations

The analysis of EM3's business model contributes to broadening the understanding of the potential of "uberization" models in agricultural mechanization services. In this sense, the assessment allows offering some recommendations for further analysis of these models.

As mentioned by Filippova (2014, para. 2): "As with technology, the problem is not the collaborative (sharing) economy itself but, at least partly, the way we have been thinking about it and the unlimited hopes we were putting into it". In this regard, as part of the Sharing Economy, "uberization" should be conceived as a new tool which could ease the farmers' access to mechanization services, nevertheless, it should not be considered as the single solution to the challenges that the provision of these services usually entails. In fact, digital tools could play a role in improving the farmers' access to mechanization but need to be supported by other factors that are determinant for the operation of these models.

In this context, the tractor operators' and farmers' use and understanding of smartphones and technological devices play a substantial role in ensuring the success of "uberization" models. In the case of India, if the government and the companies promoting new business models aim to reach farmers through the use of digital platforms, the correct use of digital tools by the stakeholders involved should not be assumed. In fact, there is a crucial need to develop the

farmers' digital empowerment in the next years. Increasing the farmers' awareness of the benefits of digital tools and provide them with training about the use of new technologies could significantly increase the impact of initiatives such as "uberization". Moreover, EM3 could develop pilot training programs in order to introduce some of the users of mechanization services to the use of digital platforms. This could contribute to the company's assessment of the real potential of the implementation of a digital platform that matches the farmers with the franchises.

Additionally, considering that according to the results, 98 percent of the farmers already own a mobile phone, options less technologically ambitious but efficient could also help farmers to improve their access to mechanization services. In fact, initiatives such as the call center established by EM3 already represent a step forward in this direction. Although allowing farmers to place requests for farm services through a phone call can be considered as a less revolutionary model approach than doing it through a digital platform, this initiative is already showing some positive results in the study area. In addition, the high rate of farmers using mobile phones in the study area could be further used by EM3 to promote their services. For example, allowing farmers to hire the service through an SMS could be a more feasible option than with an app because some farmers are more familiar with this approach. Furthermore, the company and the franchises could advertise more of their services and machinery through mobile calls. Thus, the development of new tools that aim to improve access to farm services should be adapted to the local context and consider the stakeholders' access and use of these tools.

The ranking of TC for the different contractual arrangements shows that uncertainty and group activities have been to some extent reduced by EM3's franchises. However, the analysis did not evaluate other attributes, such as the users' ability to evaluate the quality of the service and the complexity of the contracts between the farmers and the mechanization providers. In this sense, transaction costs could be further reduced if EM3 includes means to estimate them on its business model. If eventually an app is implemented, the option to rate the service could be included, following the approach by Uber, which would allow farmers to show their opinion about the quality of the service they received. EM3 could use this information to address the main weaknesses and complains about the model and the work of the franchises. Moreover, EM3 could use the data collected through the work during different cropping cycles in its operation areas in order to plan a crop and machinery calendar. In fact, based on their experience in the field, EM3 franchises could identify when and how mechanization services should be provided in different areas, which could contribute to reducing TC. Together with the aggregation of franchises, this could contribute to increasing the number of machinery during

windows of high demand, which would result in higher availability rate, less waiting time, and therefore, lower uncertainty.

EM3 should implement strategies in order to avoid the principal-agent problem. Considering that in many cases the franchise owners hire external operators to handle the machinery, the company's ability to ensure the correct provision of the service is still limited. In this regard, enforcing the implementation of GPS devices in the machinery operated by the franchisees could increase the accountability of their services. Having more information regarding the distances covered by the machinery, their diesel consumption, maintenance checkups, and an estimation of their idle time could help the company and the franchises to improve the quality of their services and evaluate the performance of the machinery.

Additionally, although one of the main goals of the model is to increase the smallholder farmers access to machinery, there is no evidence of any regulation or incentive that prioritizes this group of farmers among the franchises' work. In this regard, the GOR could implement a guideline which ensures that a specific share of the farm services is provided to marginal and small farmers. This could be addressed by guaranteeing that a percentage of the compulsory 650 hours of work are exclusively provided to small and marginal farmers. Alternatively, an incentive-based system could be designed by GOR and EM3, in which franchises that provide a higher share of services to small farmers are asked less than 650 compulsory hours of work

Furthermore, EM3 could offer alternatives to support the franchises to fulfill the yearly minimum requirement of 650 hours per piece of machinery subsidized. For instance, the requirement of working hours could be reestimated taking into consideration the influence of transaction costs such as the frequency or asset specificity of the machinery. In fact, tractors, cultivators, and seed drills display a higher frequency by the farmers, which offers the franchises better chances of fulfilling the mínimum requirement. In contrast, for implements such as sprayers, which show less frequency, the requirement might be more difficult to fulfill. Hence, a better estimation of the hours of work based on the type of machinery combined with an incentive to work with small farmers and to participate in aggregation could contribute to the franchises' fulfillment of the mínimum amount of time required.

The analysis of EM3's model shows that many of the franchises decided to start working with this company in order to obtain a subsidy for new machinery. Though, it is key to assess how the model of machinery services provision could work without a subsidy and if it could still be sustainable. In comparison, the model used by Uber does not offer any financial support to the drivers. The main incentive which attracts providers to enroll with this model relies on the platform's capacity to increase the drivers' workflow. In this sense, the sustainability of EM3's model depends on the evolution of the platform and its capacity to permanently offer franchises with enough amount of customers.

Overall the development of ICT technologies which aim to innovate the provision of mechanization services, such as “uberization”, have high potential to reduce some of the problems that farmers face to access machinery. They introduce a framework which could decrease uncertainty in the transactions, ease the payment options, and match the supply and demand more efficiently and in real time. Nonetheless, they do not seem to offer a solution for some key market failures. In fact, aspects such as the digital gap faced by farmers in developing countries, the deficiency of advanced machinery, and the lack of training among the operators cannot be solved by the installment of digital platforms. In this regard, the experience of India shows that one alternative to filling some of these gaps is the participation of the state through the provision of a subsidy, although this can be the cause of some governance issues, such as elite capture, and the principal-agent problem. Hence, governments and development agencies could strengthen the potential of these innitiatives by tackling the market and state failures arising from their adoption.

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Sections: 7, Sub-sections: 4,
Questions: 155.
Questions with enabling conditions: 69
Questions with validation conditions:20
Rosters: 6
Variables: 2

Access to mechanization services in Rajasthan, the case study of EM3

SURVEY IDENTIFICATION INFORMATION QUESTIONNAIRE DESCRIPTION

Basic information

Title	Access to mechanization services in Rajasthan, the case study of EM3

Survey data information

Study type	Agricultural Survey
Kind of data	Sample survey data [ssd]
Mode of Data Collection	Face-to-Face

Survey information

Country	India
Year	2018
Languages	English, Hindi
Unit of analysis	Households in Rajastan
Coverage	200
Primary Investigator	Roberto Villalba
Funding	German Federal Ministry of Economic Cooperation and Development (BMZ)

Additional info

Keywords	Mechanization, transaction costs, ICT models

CONSENT FORM

STATIC TEXT

ENUMERATOR: Find a respondent who is well informed about the household and the household's agricultural production and atleast 18 years old.

STATIC TEXT

This survey is done jointly by the University of Hohenheim (Germany), EM3 Agri Services and the Indian Institute of Management Udaipur. It aims to studying how the access to tractor services can be improved by mobile phone services. Your help in answering these questions is very much appreciated. Your responses will be kept COMPLETELY CONFIDENTIAL to the maximum extent allowable by law. If you choose to participate, you may refuse to answer certain questions, or you may stop participating at any time. Please swipe forward to continue.

Do you agree to participate in the survey?

I Do not record an answer to this question until you have conveyed the introductory statement to the respondent.

SINGLE-SELECT consent

01 ○ Yes
02 ○ No

HOUSEHOLD ID

1. Enter time

DATE: CURRENT TIME time

2. Add location

GPS GPS

N

W

A

3. Questionnaire number (HHID)

NUMERIC: INTEGER hhNumber

4. Please select the district of the Household

SINGLE-SELECT district

01 ○ Kota
02 ○ Bundi
03 ○ Baran
77 ○ Other

Which other district?

E district==77

TEXT other_district

5. What is the name of the Gram panchayat?

TEXT GP

6. Please write the name of the Household village	TEXT village
7. Name and Lastname of the respondent	TEXT namerespondent
8. Age of the respondent	NUMERIC: INTEGER age
9. Gender of the respondent:	SINGLE-SELECT respondent_gender 01 ○ Male 02 ○ Female
10. Cellphone number	TEXT telephone

SECTION 1. HOUSEHOLD DEMOGRAPHIC AND ECONOMIC INFORMATION

SECTION 1. HOUSEHOLD DEMOGRAPHIC AND ECONOMIC INFORMATION

1. HOUSEHOLD HEAD INFORMATION

1. Is %namerespondent% the Household Head?	SINGLE-SELECT a03 01 ○ Yes 02 ○ No
What is the respondent's relationship to the Household head? E a03==2	SINGLE-SELECT hhrelation 02 ○ Spouse 03 ○ Daughter/Son 04 ○ Adopted or foster child 05 ○ Mother/father 06 ○ Sister/brother 07 ○ Niece/nephew 08 ○ Uncle/aunt 09 ○ Mother/father in law 10 ○ Sister/brother in law 11 ○ Grandparents 12 ○ Other relative 13 ○ Domestic employee who lives with the household 14 ○ Other employee who lives with the household 15 ○ Other non-relative
What is the name of the household head? E a03==2	TEXT namehhhead
What is the Household's head gender? E a03==2	SINGLE-SELECT hhhgender 01 ○ Male 02 ○ Female

What is the Household's head age? (in completed years)

NUMERIC: INTEGER — hhead_age

E a03==2
E1 self.InRange(0,110)
M1 Reported age is unlikely. Please confirm.

2. What is the Household's head religion?

SINGLE-SELECT — roster_rel

- 01 Hinduism
- 02 Islam
- 03 Christian
- 04 Sikhism
- 05 Buddhism
- 06 Jainism
- 07 Zoroastrianism
- 88 Other
- 89 Don't know

3. Does the Household's head belong to any farmer's organization?

SINGLE-SELECT — organization_yesno

- 01 Yes
- 02 No

To what kind of organization?

E organization_yesno==1

SINGLE-SELECT — type_organization

- 01 Cooperative/association
- 02 Farmer-based organization
- 03 Women`s group or organization
- 04 Youth group or organization
- 05 Church-based or faith-based association/group
- 06 water users association
- 07 political party
- 08 tractor-owners-group
- 09 Block farm
- 10 Others, specify

Please comment others:

I Summarize what the respondent says in few words
E type_organization==10

TEXT — organization_others

4. Does the Household head play a major role in the community?

SINGLE-SELECT — role_community

- 01 None
- 02 Village Chief
- 03 Queen mother
- 04 Chairperson of a village committee/association
- 05 Religious leader
- 06 Chief farmer
- 07 Community health worker
- 08 Other (specify)

Please comment others:

I Summarize what the respondent says in few words
E role_community==8

TEXT — others_communityrole

5. What is the household's head marital status?	SINGLE-SELECT hhmarital 01 ○ Married 02 ○ Free union 03 ○ Widow/widower 04 ○ Divorced 05 ○ Single
6. How many members does the Household have? (including the Household head)	NUMERIC: INTEGER no hhmembers
7. What is Household's head highest level of formal education completed?	SINGLE-SELECT edu hhhead 01 ○ No formal education 02 ○ First Standard 03 ○ Second Standard 04 ○ Third Standard 05 ○ Fourth Standard 06 ○ Fifth Standard 07 ○ Sixth Standard 08 ○ Seventh Standard 09 ○ Eight Standard 10 ○ Ninth Standard 11 ○ Tenth Standard 12 ○ Eleventh Standard 13 ○ Twelveth Standard 14 ○ Diploma 15 ○ Graduation 16 ○ Post-Graduation
8. Does the Household head work in the farm?	SINGLE-SELECT workfarm 01 ○ Full time 02 ○ Halftime 03 ○ Does not work at the farm
10. Does the Household have access to extension service?	MULTI-SELECT extension access 01 ☐ None 02 ☐ Public 03 ☐ Private 04 ☐ Third sector (NGO)
11. Does the Household have access to credit facilities?	SINGLE-SELECT credit_access 01 ○ Yes 02 ○ No
12. What is the amount of travel time (in minutes) required to access nearest village market?	NUMERIC: INTEGER access market

SECTION 1. HOUSEHOLD DEMOGRAPHIC AND ECONOMIC INFORMATION

2. OFF-FARM INCOME

1. Does all of your income depend on the in-farm activity?	SINGLE-SELECT yesno offfincome 01 ○ Yes 02 ○ No

2. Which other soruces of income do you have?

E yesno_offfincome==2

MULTI-SELECT off_farmocup

01 ☐ Agricultural labour (casual+permanent)
02 ☐ Casual non-agricultural employment
03 ☐ Permanent non-agricultural employment
04 ☐ Provider of agricultural mechanization
77 ☐ Others, specify

Please comment others:

I Summarize what the respondent says in few words
E off_farmocup.ContainsAny(77)

TEXT farmocup_others

SECTION 1. HOUSEHOLD DEMOGRAPHIC AND ECONOMIC INFORMATION / 2. OFF-FARM INCOME

Roster: OFF-FARM OCCUPATION

generated by multi-select question off_farmocup off_farm_activ

On average, how many months per year do you work in %rostertitle%?

E1 months_offfarmincome<=12
M1 Number of months is unlikely, please check!

NUMERIC: INTEGER months_offfarmincome

On average, how many days per month do you work in %rostertitle%?

E1 days_offfarmincome<30
M1 Number of days is unlikely, please check!

NUMERIC: INTEGER days_offfarmincome

SECTION 2. MECHANIZATION OWNERSHIP

1. Do you own any mechanization equipment?

SINGLE-SELECT MECH_own

01 ○ Yes
02 ○ No
03 ○ Don't know/Refused

2. Which machinery/equipments do you own?

E MECH_own==1

MULTI-SELECT own_implement

01 ☐ Tractor
02 ☐ Power Tiller
03 ☐ Combine harvester
04 ☐ Thresher
05 ☐ Rotavator
06 ☐ Rice transplanter
07 ☐ Reaper
08 ☐ Multi -crop planter
09 ☐ Laser land leveller
10 ☐ Power weeder
11 ☐ Plow
12 ☐ Sprayer
13 ☐ Harrow
14 ☐ Cultivator
15 ☐ Seed drill
77 ☐ Other

Roster: AGRICULTURAL MACHINERY

generated by multi-select question own implement

machroster

E MECH_own==1

---

3. How many %rostertitle%s do you own?

NUMERIC: INTEGER — number asset

---

4. When was the %rostertitle% acquired?

DATE — year asset

---

5. What is the brand of the %rostertitle%?

SINGLE-SELECT — brand_asset

- 01 ○ John Deere
- 02 ○ Mahindra
- 03 ○ Swaraj
- 04 ○ Sonalika
- 05 ○ Shaktiman
- 06 ○ New Holland
- 07 ○ Tafe
- 08 ○ Massey Ferguson
- 09 ○ Farmtrac
- 10 ○ Ford
- 11 ○ Others

Please briefly comment others:

I Summarize what the respondent says in few words

E brand_asset==11

TEXT — others_brand

---

6. For which stages do you use the %rostertitle%?

MULTI-SELECT — stages_ownmech

- 01 ☐ LAND PREPARATION
- 02 ☐ SOWING
- 03 ☐ CROP CARE
- 04 ☐ HARVEST
- 05 ☐ POSTHARVEST

What is the Horsepower of the %rostertitle%?

E own_implement.ContainsAny(1)

E1 horsepower.InRange(30,900)

M1 Reported value is unlikely. Please confirm.

NUMERIC: INTEGER — horsepower

---

7. Why did you decide to buy the %rostertitle%?

MULTI-SELECT: ORDERED — reasonsown

- 01 ☐ to improve farm timeliness
- 02 ☐ to expand/scale up farming
- 03 ☐ to save time
- 04 ☐ to increase yield
- 05 ☐ to increase the precision of work
- 06 ☐ to provide hiring services
- 07 ☐ replace older machines
- 08 ☐ to be independent
- 09 ☐ Others

Please briefly comment others:

I Summarize what the respondent says in few words

E reasonsown.ContainsAny(9)

TEXT — others_reasonsown

8. Do you use the %rostertitle% to offer mechanization services to other farmers in your area?

SINGLE-SELECT offermech_yesno

01 ○ Yes
02 ○ No

9. How many clients did you serve in the last season using the %rostertitle%?

E offermech_yesno==1
W1 offermech_clients<=100
M1 Number is unlikely, please check.

NUMERIC: INTEGER offermech_clients

10. Is the %rostertitle% owned by a group?

SINGLE-SELECT group_owned

01 ○ Yes
02 ○ No
03 ○ Don't know/Refused

11. When you bought the %rostertitle% was this equipment new or used?

SINGLE-SELECT new_used

01 ○ New
02 ○ Used

12. Was the %rostertitle% used during the last season?

SINGLE-SELECT use_lastseason

01 ○ Yes
02 ○ No

13. What is the price you paid for the %rostertitle%? (in INR)

NUMERIC: INTEGER price_asset

SECTION 3. ACCESS TO MECHANIZATION

1. In the last year (Oct 17 - Sep 18) have you used mechanization services for any of the stages of the agricultural process?

SINGLE-SELECT mech_use

01 ○ Yes
02 ○ No

2. Why have you decided to access mechanization services in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE SELECT ONLY FIVE OPTIONS IN PRIORITY FROM 1 TO 5)

I ASK RESPONDENT TO GIVE THE 3 MOST IMPORTANT REASONS
E mech_use==1

MULTI-SELECT: ORDERED reasons_yes

01 ☐ to enhance farm yields
02 ☐ to reduce effort
03 ☐ to cultivate more agricultural land
04 ☐ to improve timeliness and allow quick performance
05 ☐ suggested by extension
06 ☐ because of labour shortages
07 ☐ because of increasing wages
08 ☐ because hired labor is difficult to supervise
09 ☐ to save family labour for different purposes
10 ☐ to make farming attractive to the youth
11 ☐ others, specify

Please briefly comment others:

I Summarize what the respondent says in few words
E reasons_yes.ContainsAny(11)

TEXT others_reasons_yes

3. Have you ever heard about SAMADHAN/EM3?

E mech_use==1

SINGLE-SELECT heard_EM3

01 ○ Yes
02 ○ No

4. Have you ever used SAMADHAN/EM3?

E heard_EM3==1

SINGLE-SELECT heard_user

01 ○ Yes
02 ○ No

Why have you decided not to access mechanization services in the LAST YEAR (Oct 17 - Sep 18)?

E mech_use==2

MULTI-SELECT: ORDERED reasons_no_gen

01 ☐ own machinery
02 ☐ lack of information/knowledge on machines (mechanization)
03 ☐ lack of access to machinery needed
04 ☐ quality of service is unreliable
05 ☐ price of service is too high
06 ☐ too little land/pull together with other farmers
07 ☐ too much time needed to access mechanization
08 ☐ the service does not come on time
09 ☐ uses labor
10 ☐ afraid of soil erosion
11 ☐ do not know the reason
12 ☐ others, specify

STATIC TEXT

E mech_use==1

In the following section we will ask you about the use of mechanization for the different stages of agricultural production during the LAST YEAR (Oct 17 - Sep 18)

SECTION 3. ACCESS TO MECHANIZATION

3.2 STAGES MECHANIZATION

E mech_use==1

SECTION 3. ACCESS TO MECHANIZATION / 3.2 STAGES MECHANIZATION

Roster: STAGES MECHANIZATION

generated by fixed list stages

01 LAND PREPARATION
02 SOWING
03 CROP CARE
04 HARVEST
05 POSTHARVEST

E mech_use==1

1. Have you used mechanization for %stages% in THE LAST YEAR (Oct 17 - Sep 18))?

SINGLE-SELECT mechstages_yesno

01 ○ Yes
02 ○ No

Why have you decided not to access mechanization services for %stages% in the LAST YEAR (Oct 17 - Sep 18)?

F mechstages_yesno==2
E mechstages_yesno==2

MULTI-SELECT: ORDERED — reasons no

- 01 ☐ own machinery
- 02 ☐ lack of information/knowledge on machines (mechanization)
- 03 ☐ lack of access to machinery needed
- 04 ☐ quality of service is unreliable
- 05 ☐ price of service is too high
- 06 ☐ too little land/pull together with other farmers
- 07 ☐ too much time needed to access mechanization
- 08 ☐ the service does not come on time
- 09 ☐ uses labor
- 10 ☐ afraid of soil erosion
- 11 ☐ do not know the reason
- 12 ☐ others, specify

Please briefly comment others:

I Summarize what the respondent says in few words
E reasons_no.ContainsAny(12)

TEXT — others reasons no

.....

2. How did you access mechanization services for %stages% during the LAST YEAR (Oct 17 - Sep 18)?

E mechstages_yesno==1

SINGLE-SELECT — mech structure

- 01 ○ Own mechanization
- 02 ○ Samadhan centers
- 03 ○ Informal sharing
- 04 ○ Contractors
- 05 ○ Farmer groups
- 06 ○ Cooperatives
- 07 ○ Government
- 77 ○ Other

Please briefly comment others:

I Summarize what the respondent says in few words
E mech_structure==77

TEXT — others_mech_struct

.....

SECTION 3. ACCESS TO MECHANIZATION / 3.2 STAGES MECHANIZATION / STAGES MECHANIZATION

MECHANIZATION SERVICE

E mech_structure.InList(2,3,4,5,6,7,8)

1. Why did you hire mechanization services for %stages% with the %mech_structure% instead than with other providers in the LAST YEAR (Oct 17 - Sep 18)?

I ASK THE RESPONDENT TO CHOOSE ONLY 3 REASONS

MULTI-SELECT: ORDERED — why_MP

- 01 ☐ The machinery requirements can be better fulfilled by this provider
- 02 ☐ Previous friendship/relationship with the service provider
- 03 ☐ Simpler request process
- 04 ☐ Service comes on time
- 05 ☐ Only alternative to access mechanization in the region
- 06 ☐ Price is more convenient than the others
- 07 ☐ Quality of the service is better
- 08 ☐ Suggested by extension service
- 09 ☐ Other, specify

Please briefly comment others:

I Summarize what the respondent says in few words
E why_MP.ContainsAny(9)

TEXT others_why_MP

2. How did you become aware of the %mech_structure%?

MULTI-SELECT aware

- 01 ☐ Through friend/neighbor/family
- 02 ☐ Through media
- 03 ☐ Through extension workers
- 04 ☐ Other

Please briefly comment others:

I Summarize what the respondent says in few words
E aware.ContainsAny(4)

TEXT others_aware

3. How do you usually contact the %mech_structure%?

SINGLE-SELECT contact_MP

- 01 ○ By telephone (Call)
- 02 ○ SMS Message
- 03 ○ Step by the center
- 04 ○ Informal talks
- 05 ○ Internet
- 06 ○ Other

Please briefly comment others:

I Summarize what the respondent says in few words
E contact_MP==6

TEXT others_contact_MP

4. When you hire the %mech_structure%, are you able to select which kind of equipment and operator come to your farm?

SINGLE-SELECT select_MP

- 01 ○ Yes, every time
- 02 ○ Sometimes, depending on timeliness and season
- 03 ○ Never
- 04 ○ Others, specify

Please briefly comment others:

I Summarize what the respondent says in few words
E select_MP==4

TEXT others_select_MP

5. What kind of machinery/equipment did you hire with the %mech_structure% for %stages% in the LAST YEAR (Oct 17 - Sep 18)?

MULTI-SELECT stages_equip_MP

- 01 ☐ Tractor
- 02 ☐ Power Tiller
- 03 ☐ Combine harvester
- 04 ☐ Thresher
- 05 ☐ Rotavator
- 06 ☐ Rice transplanter
- 07 ☐ Reaper
- 08 ☐ Multi -crop planter
- 09 ☐ Laser land leveller
- 10 ☐ Power weeder
- 11 ☐ Plow
- 12 ☐ Sprayer
- 13 ☐ Harrow
- 14 ☐ Cultivator
- 15 ☐ Seed drill
- 77 ☐ Other

Please briefly comment others:

I Summarize what the respondent says in few words
E stages_equip_MP.ContainsAny(77)

TEXT — others_stages_equipMP

---

6. In the LAST YEAR (OCT 17 - SEP 18) how many times was %mech_structure%'s machinery for %mech_structure% NOT AVAILABLE when you needed it?

NUMERIC: INTEGER — availability

---

7. How many times in THE LAST YEAR (Oct 17 - Sep 18) did you hire the %mech_structure% for %stages%?

NUMERIC: INTEGER — freq_hired

---

8. How many days did it take you to find the right machinery and operator for %stages%?

E1 days_find.InRange(1,20)
M1 Number of days is unlikely, please check!

NUMERIC: INTEGER — days_find

---

9. How many days after you requested the service did you have to wait until the %mech_structure%'s operator came with the machinery to your farm?

E1 days_request.InRange(1,20)
M1 Number of days is unlikely, please check!

NUMERIC: INTEGER — days_request

---

10. Did you approach the %mech_structure% but were refused?

SINGLE-SELECT — MP_refusal_yesno

- 01 ○ Yes
- 02 ○ No

Why were you refused?

E MP_refusal_yesno==1

MULTI-SELECT — MP_why_refusal

- 01 ☐ high demand/not able to fulfill request
- 02 ☐ small farm size
- 03 ☐ remote plots/service not available in the area
- 04 ☐ stumpes/stone in field
- 05 ☐ don't know / refused
- 06 ☐ other

Please briefly comment others:

I Summarize what the respondent says in few words
E MP_why_refusal.ContainsAny(6)

TEXT — MP_otherswhy_refusal

Did you know the machinery provider before he became SAMADHAN?

E mech_structure==2

SINGLE-SELECT — knew_befSAMADHAN

- 01 ○ Yes
- 02 ○ No

---

11. Last year (2017), did you also hire %mech_structure% for %stages%?

SINGLE-SELECT — MP_lastyear

- 01 ○ Yes
- 02 ○ No

How did you access mechanization for %stages% LAST YEAR?

E MP_lastyear==2

SINGLE-SELECT — MP_lastyear_diff

01 ○ Own mechanization
02 ○ Samadhan centers
03 ○ Informal sharing
04 ○ Contractors
05 ○ Farmer groups
06 ○ Cooperatives
07 ○ Government
77 ○ Other

Please briefly comment others:

I Summarize what the respondent says in few words
E MP_lastyear_diff==77

TEXT — others_MP_lastyear

What has changed after you stopped hiring %MP_lastyear_diff% and started hiring %mech_structure%? (PLEASE SELECT UP TO 3 OPTIONS)

I ASK THE RESPONDENT TO GIVE 3 REASONS
E MP_lastyear==2

MULTI-SELECT: ORDERED — change_MP

01 ☐ Waiting time
02 ☐ Acess to mechanization
03 ☐ Quality of the service
04 ☐ Price transparency
05 ☐ Quality of equipment
06 ☐ Nothing
77 ☐ Others

Please briefly comment others:

I Summarize what the respondent says in few words
E change_MP.ContainsAny(77)

TEXT — others_change_em3

12. How did you pay for the %mech_structure%'s service for %stages%?

SINGLE-SELECT — payment_MP

01 ○ In Kind
02 ○ Cash
03 ○ Others

Please briefly comment others:

I Summarize what the respondent says in few words
E payment_MP==3

TEXT — others_payment_MP

13. Was the price for %stages% agreed with %mech_structure% BEFORE the service?

SINGLE-SELECT — price_agreement

01 ○ Yes
02 ○ No

14. Have you ever had the impression that the %mech_structure% cheated with the price of %stages%?

SINGLE-SELECT — cheat

01 ○ Yes
02 ○ No

15. When did you pay the %mech_structure% for %stages%?

SINGLE-SELECT — when_MP_payment

01 ○ Right after service provision
02 ○ At the end of the season (after harvest)
03 ○ Others

Please briefly comment others:

I Summarize what the respondent says in few words
E when_MP_payment==3

TEXT — others_when_payMP

16. How was the fee for tractor services utilization under the %mech_structure% charged for %stages%?

SINGLE-SELECT — MP payment unit

01 ○ Per hour
02 ○ Per acre
03 ○ Per bigha

17. For how much land did you hire the %mech_structure% services for %stages%?

TEXT — MP_tractor_land

.....

18. How much time (in hours) did the %mech_structure% need for %stages%?

NUMERIC: DECIMAL — MP_tractor_time

- -

19. How much did you pay to the %mech_structure% (in INR) for %stages% %MP_payment_unit%?

NUMERIC: DECIMAL — MP_tractorrent_cost

- -

20. Does %mech_structure% ask you for service feedback?

SINGLE-SELECT — feedback MP

01 ○ Yes
02 ○ No

How often does %mech_structure% ask you for service feedback?

E feedback_MP==1

SINGLE-SELECT — feedback_MP_freq

01 ○ Always
02 ○ Sometimes

How do you give feedback to %mech_structure%?

E feedback_MP==1

SINGLE-SELECT — feedback MP how

01 ○ By telephone (Call)
02 ○ SMS Message
03 ○ Step by the center
04 ○ Informal talks
05 ○ Internet
06 ○ Other

21. Does the %mech_structure% require to have a minimum ammount of land to do %stages%?

SINGLE-SELECT — pulltogether

01 ○ Yes
02 ○ No

22. How satisfied are you with the mechanization services provided by the %mech_structure% for %stages% in the LAST YEAR (Oct 17 - Sep 18)? (on a scale of 1 to 5)

SINGLE-SELECT — MP_satisfaction1

01 ○ 1) Very dissatisfied / Very Bad
02 ○ 2) Dissatisfied / Bad
03 ○ 3) Not Unsatisfied / Not Satisfied
04 ○ 4) Satisfied / Good
05 ○ 5) Very Satisfied / Very Good

Why are you not satisfied with the services provided by the %mech_structure%? (PLEASE SELECT ONLY FIVE OPTIONS IN PRIORITY FROM 1 TO 5)

E MP_satisfaction1.InList(1,2,3)

MULTI-SELECT: ORDERED — MP nonsatisfact

01 ☐ service not available in time
02 ☐ service too expensive
03 ☐ tedious application to service
04 ☐ bad quality of service (e.g. weeds not properly covered)
05 ☐ service cause soil erosion problems
06 ☐ needs not met
07 ☐ someone try to cheat
08 ☐ others, specify

Please briefly comment others: I Summarize what the respondent says in few words E MP_nonsatisfact.ContainsAny(8)	TEXT MP_otherswhy_mechhirenonsatisf
23. How would you describe the process of accessing mechanization with the %mech_structure%? (on a scale of 1 to 5)	SINGLE-SELECT complexity_MP 01 ○ 1) Very complicated 02 ○ 2) Complicated 03 ○ 3) Intermediate 04 ○ 4) Easy 05 ○ 5) Very easy
24. Would you use the services of the %mech_structure% again next season?	SINGLE-SELECT MP_hireagain 01 ○ Yes 02 ○ No

SECTION 4. LAND USE & CROP PRODUCTION

STATIC TEXT

IN THIS SECTION WE WILL ASK YOU INFORMATION RELATED TO THE LAND YOU OWN AND THE CROPS YOU PRODUCE EVERY SEASON

1. In which unit do you measure land?	SINGLE-SELECT unit_land 01 ○ Bighas 02 ○ Acres 03 ○ Hectares 04 ○ Others, specify
What is the equivalence of Bigha to Hectares or Acres in this area? I INTERVIEWER WRITES DOWN THIS WITHOUT ASKING TO THE FARMER E unit_land==1	TEXT unit_equivalence
2. How much land do you own?	NUMERIC: DECIMAL land_owned
Please comment others: I Summarize what the respondent says in few words E unit_land==4	TEXT others_unitsland
3. How many %unit_land% do you rent in?	NUMERIC: DECIMAL land_rentin
VARIABLE land_owned+land_rentin	DOUBLE total_landvar
4. How much of the %total_landvar% %unit_land% are cultivated?	NUMERIC: DECIMAL land_cultivated
5. How much of the %total_landvar% %unit_land% are irrigated?	NUMERIC: DECIMAL land_irrigated

What are the main reasons for not cultivating the whole land you own/control? (PLEASE SELECT UP TO 5 OPTIONS)

E land_cultivated<total_landvar

MULTI-SELECT: ORDERED reasons gapland

- 01 ☐ shifting cultivation (to regain soil fertility)
- 02 ☐ limited access to mechanizaton
- 03 ☐ limited access to laborers
- 04 ☐ drought
- 05 ☐ floods
- 06 ☐ access to credit
- 07 ☐ access to seeds/planting material
- 08 ☐ access to inputs
- 09 ☐ others, specify

6. How many plots does the Household manage?

E1 numberplots.InRange(1,15)
M1 Value unlikely. Please confirm

NUMERIC: INTEGER numberplots

SECTION 4. LAND USE & CROP PRODUCTION

Roster: SEASON

generated by fixed list season_roster

- 01 Kharif
- 02 Rabi

7. Which crops did you grow in %season_roster% in the LAST YEAR (Oct 17 - Sep 18)?

MULTI-SELECT: ORDERED crops grown

- 01 ☐ Bajra
- 02 ☐ Barley
- 03 ☐ Castorseed
- 04 ☐ Chowla
- 05 ☐ Cotton
- 06 ☐ Gram
- 07 ☐ Groundnut
- 08 ☐ Guwar Seed
- 09 ☐ Jowar
- 10 ☐ Lentil
- 11 ☐ Linseed
- 12 ☐ Maize
- 13 ☐ Moong
- 14 ☐ Moth
- 15 ☐ Peas
- 16 ☐ Rapeseed & Mustard

And 10 other symbols [1]

Which other crops?

I Summarize what the respondent says in few words
E crops_grown.ContainsAny(99)

TEXT others crops

8. How did you grow the crops during %season_roster% in the LAST YEAR (Oct 17 - Sep 18)?

SINGLE-SELECT agric system

- 01 ○ Intercropped
- 02 ○ Separetely

SECTION 4. LAND USE & CROP PRODUCTION / SEASON

Roster: CROP PRODUCTION

9. How much of the %land_cultivated% %unit_land% did you dedicate to the production of %rostertitle% during %season_roster% in the LAST YEAR (Oct 17 - Sep 18)?

NUMERIC: DECIMAL landpercrop

E1 landpercrop<=land_cultivated
M1 Land dedicated to the crop is larger than the size of the plot, please ch eck.

10. How much %rostertitle% seed did you use during %season_roster% in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT NUMBER)

NUMERIC: DECIMAL qty_seed

E1 qty_seed<=5000
M1 Value is unlikely, please check!

11. In which unit did you measure the quantity of seed used?

SINGLE-SELECT unit_seed

E qty_seed>0

01 ○ Kilogram
02 ○ Litre
03 ○ 90 Kg bag
04 ○ 50 Kg bag
05 ○ 25 Kg bag
06 ○ Other (specify)

Please comment others:

TEXT others_unitseed

I Summarize what the respondent says in few words
E unit_seed==6

12. How much (INR) did you pay for every %unit_seed% of %rostertitle% seed in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT NUMBER)

NUMERIC: DECIMAL price_seed

E qty_seed>0
E1 price_seed<=5000
M1 Value is unlikely, please check!

13. How much fertilizer did you use for %rostertitle% during %season_roster% in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT NUMBER)

NUMERIC: DECIMAL qty_fertilizer

E1 qty_fertilizer<=5000
M1 Value is unlikely, please check!

14. In which unit did you measure the quantity of fertilizer used?

SINGLE-SELECT unit_fertilizer

E qty_fertilizer>0

01 ○ Kilogram
02 ○ Litre
03 ○ 90 Kg bag
04 ○ 50 Kg bag
05 ○ 25 Kg bag
06 ○ Other (specify)

Please comment others:

TEXT others_unitsfertilizer

I Summarize what the respondent says in few words
E unit_fertilizer==6

15. How much (INR) did you pay for every %unit_fertilizer% of fertilizer for %rostertitle% in the LAST YEAR (Oct 17 - Sep 18) ? (PLEASE INSERT NUMBER)

E qty_fertilizer>0
E1 price_fertilizer<=500000
M1 Value is unlikely, please check!

NUMERIC: DECIMAL price_fertilizer

16. How much farm manure did you use for %rostertitle% during %season_roster% in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT NUMBER)

E1 qty_manure<=5000
M1 Value is unlikely, please check!

NUMERIC: DECIMAL qty_manure

17. In which unit did you measure the quantity of manure used?

E qty_manure>0

SINGLE-SELECT unit_manure

01 ○ Kilogram
02 ○ Litre
03 ○ 90 Kg bag
04 ○ 50 Kg bag
05 ○ 25 Kg bag
06 ○ Other (specify)

Please comment others:

I Summarize what the respondent says in few words
E unit_manure==6

TEXT others_unitmanure

18. How much (INR) did you pay for every %unit_manure% of manure for %rostertitle% in the LAST YEAR (Oct 17 - Sep 18) ? (PLEASE INSERT NUMBER)

E qty_manure>0
E1 price_manure<=5000
M1 Value is unlikely, please check!

NUMERIC: DECIMAL price_manure

19. How much pesticides/herbicides did you use for %rostertitle% during %season_roster% in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT NUMBER)

E1 qty_pestic<=5000
M1 Value is unlikely, please check!

NUMERIC: DECIMAL qty_pestic

20. In which unit did you measure the quantity of manure used?

E qty_pestic>0

SINGLE-SELECT unit_pestic

01 ○ Kilogram
02 ○ Litre
03 ○ 90 Kg bag
04 ○ 50 Kg bag
05 ○ 25 Kg bag
06 ○ Other (specify)

Please comment others:

I Summarize what the respondent says in few words
E unit_pestic==6

TEXT others_unitpestic

21. How much (INR) did you pay for every %unit_pestic% of pesticide for %rostertitle% in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT NUMBER)

NUMERIC: DECIMAL — price_pestic

E qty_pestic>0
E1 price_pestic<=5000
M1 Value is unlikely, please check!

22. How much %rostertitle% did you produce in %season_roster% in the LAST YEAR (Oct 17 - Sep 18)? (PLEASE INSERT A NUMBER)

NUMERIC: DECIMAL — qty_output

23. In which unit did you measure the quantity of %rostertitle% produced?

SINGLE-SELECT — unit_output

01 ○ Kilogram
02 ○ Litre
03 ○ 90 Kg bag
04 ○ 50 Kg bag
05 ○ 25 Kg bag
06 ○ Other (specify)

Please comment others:

TEXT — others_unitoutput

I Summarize what the respondent says in few words
E unit_output==6

VARIABLE

plot_crop.Sum(x=>x.qty_output)

DOUBLE — Crop_output

24. Out of the %qty_output% %unit_output% of %rostertitle% harvested, how much did you sell?

NUMERIC: INTEGER — use_sell

25. What was the price (in INR) per %unit_output% of the %use_sell% %unit_output% sold?

NUMERIC: INTEGER — price_sold

E use_sell>0

26. Out of the %qty_output% %unit_output% of %rostertitle% harvested, how much did you use for own consumption?

NUMERIC: INTEGER — use_consumption

E1 use_consumption<=qty_output
M1 Quantity is larger that total output of the crop. Please verify

27. Out of the %qty_output% %unit_output% of %rostertitle% harvested, how much did you save as seed?

NUMERIC: INTEGER — use_seed

E1 use_seed<=(qty_output)-(use_consumption)
M1 Quantity is unlikely. Please verify

28. Do you own any livestock?

SINGLE-SELECT — yesno_livestock

01 ○ Yes
02 ○ No

29. What kind of livestock do you own?

E yesno_livestock==1

MULTI-SELECT livestock type

01 ☐ Cows
02 ☐ Buffalos
03 ☐ Sheep
04 ☐ Goats
05 ☐ Horses
06 ☐ Mules
07 ☐ Donkeys
08 ☐ Camels
09 ☐ Pigs
10 ☐ Poultry

SECTION 4. LAND USE & CROP PRODUCTION

Roster: NEW ROSTER

generated by multi-select question livestock type LIVESTOCK

30. How many %rostertitle% do you own?

TEXT units livestock

.....

SECTION 5. ACCESS TO MOBILE & INTERNET SERVICES

1. Do you own/use a mobile phone?

SINGLE-SELECT mobile yesno

01 ○ Yes
02 ○ No

Do you own/use a smartphone?

E mobile_yesno==1

SINGLE-SELECT smartphone_yesno

01 ○ Yes
02 ○ No

Why you do not use a smartphone?

E smartphone_yesno==2

MULTI-SELECT reasons no smart

01 ☐ Does not know how to use it
02 ☐ Does not find it useful
03 ☐ Price is too high
04 ☐ Mobile broadband is not available in the area
05 ☐ Others

Please briefly comment others:

I Summarize what the respondent says in few words
E reasons_no_smart.ContainsAny(4)

TEXT others_mobile_no

.....

Does someone else use a mobile phone in the household?

E mobile_yesno==2

SINGLE-SELECT mobilehh yeno

01 ○ Yes
02 ○ No

2. How do you usually connect to the internet?

SINGLE-SELECT internet_access

01 ○ Mobile Broadband - 3G or 4G
02 ○ Wireless at home
03 ○ Both 1 and 2
04 ○ Does not connect to the internet
05 ○ Others, specify

Please briefly comment others:

I Summarize what the respondent says in few words
E internet_access==5

TEXT others internet access

3. In the last 30 days, how many days did the internet not work?

E1 internet_satisfaction<=30
M1 Number is unlikely, please check!

NUMERIC: INTEGER internet_satisfaction

4. What is the main usage you give to your mobile phone?

E mobile_yesno==1

MULTI-SELECT mobile_use

01 ☐ To access social media
02 ☐ To take pictures
03 ☐ To call
04 ☐ To send SMS
05 ☐ To check E-mails
06 ☐ Others

Please briefly comment others:

I Summarize what the respondent says in few words
E mobile_use.ContainsAny(6)

TEXT others mobile use

5. How much money (INR) do you spend on mobile phone SERVICE per month?

E mobile_yesno==1

NUMERIC: INTEGER payment mobile

6. Do you use or have used in the past apps for any farming service?

SINGLE-SELECT ict use

01 ○ Yes
02 ○ No

APPENDIX A — OPTIONS

[1] crops_grown: 7. Which crops did you grow in %season_roster% in the LAST YEAR (Oct 17 - Sep 18)?
Options: 1:Bajra, 2:Barley, 3:Castorseed, 4:Chowla, 5:Cotton, 6:Gram, 7:Groundnut, 8:Guwar Seed, 9:Jowar, 10:Lentil, 11:Linseed, 12:Maize, 13:Moong, 14:Moth, 15:Peas, 16:Rapeseed & Mustard, 17:Rice, 18:Sesamum, 19:Small Millets, 20:Soybean, 21:Sugarcane, 22:Tarameera, 23:Tur, 24:Urad/Biri, 25:Wheat, 99:Other

LEGEND

Legend and structure of information in this file